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REPORT

OF THE

ROYAL SOCIETY of SOUTH AUSTRALIA.

VOL. VIII.

(FOR 1884-5.)

ISSUED MAY, 1886.

Adelaide:
G. ROBERTSON, 103, KING WILLIAM STREET.

1886.

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Royal Society of South Australia.

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On a Geological Section from the Head of St. Vincent Gulf Eastward across the Wakefield and Light River Basins.

By J. J. East.

Plate I.

[Read November 4, 1884.]

INTRODUCTORY.

The sectional line here spoken of extends from Port Wakefield across the Wakefield Plains, and through the Adelaide chain of the Flinders Ranges to their eastern slopes overlooking the valley of the Murray River.

The form of the ground's surface naturally suggests its division into two portions, viz., a level or gently undulating plain reaching back from the waters of the gulf for 22 miles, when it gives place to a tract of hilly country. This hill region is formed by a succession of parallel ranges having a nearly meridional strike, and separated from each other by valley-plains often of considerable extent. The ranges as a rule appear about the same average height above the plains, but on a line from west to east they really, with the valleys between, form a series of terraces, each valley and range on the east having a greater absolute elevation than that on the west. The eastern range is the highest of all, the summits of several points being over 2,000 feet above the sea. It forms a wide-topped swell many miles long, and is known as the tableland. From the eastern slope of the tableland the surface of the country falls rapidly towards the Murray River, but no long creeks nor permanent waters exist in the 35 miles of scrub and plain which intervene between that channel and the hills.

In consequence of the terraced formation of the hill country the whole of the surface drainage is towards the gulf, the western ranges being drained by the River Wakefield, and the central and eastern ones by the Light and its tributary the Gilbert.

THE WAKEFIELD PLAINS.

In describing the series of beds or strata met with along the line of section it will be advantageous to begin with the western or "plains" portion.

On the edge of the gulf at Port Wakefield a deep borehole

sunk by the Government has revealed a great thickness of Tertiary beds resting directly on a primary rock composed of blue slate containing iron pyrites and bands of quartz. The Tertiary beds have been critically discussed by Professor Tate in Vol. IV. of the Society's Transactions, &c., and by him the series are divided into two portions, the upper beds being classed as "Recent Marine" and the lower beds "Pliocene Drift."

The Recent Marine does not extend far inland, and is succeeded on the surface by red loam, underlaid by red clay, which continues to Balaklava. Sinkings at this place pierce the loam and clay at about 80 feet, and then enter water-bearing strata of sand and gravel. The same occurs at Halbury on the Blyth railway line, and at several points in the scrub south of Balaklava. East of this township the red loam is found surmounted by a crust of travertine, and this in turn is covered by 20 to 30 feet of blown sand of a light-brown colour. It is this sand which by forming mounds gives the undulating character to the plains. A fine section of the sand, travertine, and loam is exposed by a railway cutting on the Blyth line just over the bridge crossing the Wakefield. These sandhills continue right back to the ranges, and where they adjoin the older rocks often develop flat beds of a fine-grained brownish-black ferruginous sandstone, which is extensively used for road metal. The manner of its occurrence is like that of travertine, and doubtless owes its origin to similar causes—aqueous solutions concentrated by evaporation.

Along the line of section no exploration has been made deeper than the gravel which underlies the red clay, but at several points southward the search for water has resulted in greater depths being reached. The Hundreds of Dalkey and Grace are by this means pretty well known, but in no instance have the wells reached the primary rocks. Among the sandhills west of Owen railway station wells which have been sunk over a tract of country six miles wide have passed through the gravel and entered blue clay at a general depth of a little over 100 feet from the surface. Twelve miles farther south in a well at Mallala—115 feet above sea level—the blue clay was met with at a depth of 80 feet. The water supply at this depth being insufficient and of poor quality, a borehole was continued from the bottom. The blue clay continued to a depth of 150 feet further, and then the drill entered a bed of quicksand and gravel, which afforded water with such pressure that it not only rose to the top of the bore, but flooded the well to a depth of 40 feet, at which point the water has found its level, or, what is more probable, the lateral soakage is equal to the supply from below. This well was sunk by the Milling Company for

engine purposes, and the water derived is eminently suitable for such uses, being clear and soft.

Where the plain slopes up to the foot of the hills the red clay or loam is found resting directly against the primary rock, and the river channels where they debouche on the plain show only a section of this upper bed or the overlying sand and travertine. Summarised, therefore, the strata of the plain consist in descending order of—

Blown sand	30 feet
Travertine	2 "
Loam and red clay	80 "
Sand and gravel, with brackish water .	2 "
Blue clay	150 "
	264 feet

Quicksand and gravel, with abundance of good water.

THE HILLS.

The rocks composing the hill country are divisible into three groups, each unconformable to the others. The newest formation is a gritty sandstone, often a ferruginous conglomerate or breccia. The coarser portions occupy the lowest levels, and from this the transition is a gradual approach to a lighter-coloured and finer-grained sandstone, which forms a cap to almost all the ranges. No fossils have been detected in it, and has been referred to various geological ages, from Miocene to the Desert Sandstone. Extensively distributed, it is also very thick. At Macaw Creek, south of Rhynie, it forms round-backed hills 200 feet high. In the valley of the Light, between Hamilton and Anlaby, it is also greatly developed. The most extensive and unbroken series of it is met with on the Alma range, where it forms a cap and flanking formation all the way from Stockport to Saddleworth. As might be inferred, the nature of this rock varies greatly, especially the upper portions. In some places, as near Undalya, it is a coarse soft sandstone; at Rhynie and west of Stockport it is quarried as a white freestone for building purposes. At Stockport itself and near Marrabel its ferruginous beds yield splendid tough road metal. On the Marrabel range it is compact, grey, hard, and barely distinguishable lithologically from the grey quartzite forming the core of the range.

The best exposure of this series is seen at Stockport, on the bank of the River Gilbert. There the western side of the channel is formed of very coarse conglomerate, consisting of quartz stones (some of them being as large as one's fist) cemented together by a ferruginous paste. The Gilbert has cut a channel through it, and passing westward it is seen at

length bounded by slates dipping eastward. Ascending these slates, the sandstone cap is found to get finer and finer grained until, as before stated, it becomes a freestone quarried for building purposes. Where not resting directly on primary rocks this sandstone rests on blue clay similar in appearance to that found under the red clay of the plains. Such is the case at Tothill's Creek, Butcher's Gap, Woolshed Flat, Salter's Springs, and Humphrey's Springs.

The frequent occurrence of similar patches of conglomerate in the beds of creeks which are still the main drains of the tract of country in which they are situated would at first sight appear to indicate that the sandstone just spoken of had its origin in running streams. The bedding of the sandstones, however, their dip and variation in texture, while indicative of formation by currents is not consistent with lacustrine or river depositions when considered in the light of their altitudes and distributions over extensive areas.

PRIMARY ROCKS.

The series of slates, quartzites, and crystalline limestones forming the main mass of the ranges have been tentatively classed under the somewhat ambiguous term of "pre-Silurian," which term, however, commends itself as being indicative of the extreme age to which these rocks undoubtedly belong. Along the line of section they are clearly divisible into two groups—an upper and lower—both upheaved and greatly faulted, and unconformable to each other.

Upper Group.—The upper group is much the thicker of the two, and consists of slates, soft aluminous rock, quartzites, flags, and sandstones. It is seen to best advantage in the Gilbert Valley along the line of section which passes through Riverton. In descending order the rocks here met with are

Greenish grey sandy slates and soft aluminous rock.
Pink and brown earthy slates.
Blue slates containing black iron pyrites.
Olive green slate.
Brown quartzite.
Olive green sandy slates.
White slatey sandstones, soft and sometimes earthy.
Blue flags.
Bluish grey sandstones graduating into micaceous flags.

All the above beds are seen in ascending order from about one mile west of Riverton to the foot of the Marrabel range, about four miles further east. The prevailing strike is N. 10 W. and dip eastward at a mean angle of 23 deg. from the horizon. Numerous quarries abound in the three lowest beds

which are worked locally, and furnish the building stone, flags, and road metal required in the neighbourhood.

Two miles south of the town the pyritiferous slates form a hard brown ferruginous shale, which constitutes a round-back swell of about half a mile in length. This change is probably due to the oxidation of the pyrites as they at times are found studding this rock like currants in a cake. The same rock is seen in the Light channel, about three miles below Hamley Bridge, and from it I have gathered pyrites which, while externally of a clear black colour, were of the original brass yellow towards the centre. At several other places the shale occurs on the alignment of the slate, among others at Dorrington's farm on the Marrabel range, where it is scarcely one hundred yards from the unaltered bed. Paddy's Knob (in the Northern Areas) on the Germein road near Wirrabara is another instance of this localisation of chemical changes.

The two upper beds of this group contain much soluble matter, and when treated with hydrochloric acid the pink variety loses one-third of its weight. Their soft, almost friable, nature and susceptibility to chemical action is the cause of their always weathering into rolling swells with sometimes deep watercourses at their bases. North-east of Tarlee the valley is deeply cut up from this cause.

About four miles east of Riverton a fault of upthrow occurs, which brings the lowest beds again to the surface. The beds appear to be somewhat thicker also, which, though doubtless is the case, is yet made more apparently so by the dip of inclination being lessened several degrees.

The Marrabel range presents its steepest face to the west, and has undergone denudation in a very irregular manner, due principally to the varying hardness of the Tertiary sandstone by which it is capped. The blue flags are seen at the fault which passes by Ettrick's ruined church. The olive green slates occur at the foot of the range ; the brown quartzite at intervals shows bare on its summit, and half-way down the other side is a quarry in the pyritiferous blue bed which has supplied the stone to build Marrabel. The next four miles is covered by the Tertiary sandstone, and the sequence of the rocks is ascertained by wells and exposures of rock at greatly denuded points north and south of the sectional line.

Another fault in this upper group of rocks is marked by the Julia range. From here to the table-land the strata are much disturbed and occasionally the angle of dip is very high and always easterly. The table-land range, however, dips westward, and must therefore form a synclinal trough under the upper portions of Julia and Pine Creeks. The eastern face of the table-land presents a steep and sometimes bluff face, over-

looking the Murray Plains, due to its having been faulted upward from that side. This last fault is a very long one, and runs in a general direction of N.N.W. and S.S.E. from Robertstown to Leake's Lookout, a distance of over 20 miles.

From Eudunda, which stands nearly on the line of fault, the surface of the country falls rapidly towards the Murray. A few swells, mostly of sandstone, appear, and in the railway cutting at Mount Mary the last of the Primary slates are seen. After this the fossiliferous beds of the Murray basin occupy the country further eastward.

Lower Group.—What I have termed the "lower group" of rocks forms the base of the western ranges, and consist of beds of slates, crystalline limestones, and quartzites. Nowhere, as far as my observations have extended, are they exposed in full succession except so far as the lower beds are concerned. The whole series is much faulted and disturbed, and the strike and dip very variable, but the latter is always at a high angle. As the results of numerous observations I have been led to accept the following as the sequence of the different beds in descending order:—

Grey talcose slate.
Grey quartzite.
Hard blue shale.
Crystalline thin bedded limestone with talc partings.
Siliceous thin bedded marbles.
Olive-green slate.
Brownish-white sandstone.
Green and grey sandy slates.
Thick bedded grey quartzite.
Yellowish clay slate.
Massive quartzite breccia.

Although, as previously stated, the strike of particular beds is never constant, the series as a whole has a general direction of N.N.W. and S.S.E. It forms the base of the Alma Range from Stockport to the River Wakefield, and of the Skilly ranges from the Wakefield to Clare. The road which runs west of the Clare hospital has a goodly proportion of marble in the metalling. The watercourses of the Skilly ranges have eroded channels through the softer slates and limestones, and in consequence the harder quartzites and sandstones remain standing in a series of narrow high parallel ridges which effectually shut out any direct traffic from Watervale or Leasingham to the plains on the westward.

Between the Skilly ranges and the main North Railway the ground is formed by rocks of the "upper group." The upheaval of the Skilly ranges from the westward has subjected

these beds to tremendous lateral compression, by which they were thrown into a series of folds, the culminating point being Mount Horrocks. In the immediate neighbourhood of Auburn the foliation is clearly displayed by the road cuttings. Four miles eastward the Pine Creek has worn its channel completely through the slates of the upper group down to the crystalline limestone of the "lower group." The exposure of limestone at this point was observed by Prof. Selwyn in 1859, when driving from Saddleworth to Auburn. A few yards to the westward is a dyke of dolerite, which is the only eruptive rock I have observed in this district, but I am informed that fragments have been found in the Skilly ranges, near Clare, by Professor Tate. Professor Selwyn records the occurrence of a granite dyke at the confluence of the Julia and River Light, about four miles south of the section. At Pine Creek this rock is quarried for road metal.

Between Riverton and Rhynie some of the weathered boulders of marble become deeply stained with iron oxide, and have a suggestive coralline appearance, and when an unweathered fragment is ground smooth the mass is seen to be composed of shot-like concretions cemented together. Specimens of this rock have been submitted to Prof. Tate and the Government Geologist, but were not recognised as organic formations. The same rock is traceable as far south as Stockport, beyond which the rocks disappear beneath Tertiary deposits; but at Templers, nine miles from Gawler, the debris from the well is talcose slate, similar to that found in other places occupying the highest position in the "lower group" series. The Alma plain is loam and drift resting on rocks of the "upper group," and is bounded on the west by the low Dalkey Range. At Stockyard Creek the wells show talcose slate as at Dry Creek, west of Tarlee. The dip is easterly, and passing west to the Wilderness Creek, near Owen, there is an exposure of the limestones, also dipping east. Seven miles north of this, where the Wakefield River forces its way through a gap on to the Wakefield Plains, the sequence of the rocks is again observable in the natural section there formed. This Dalkey Range, though much lower in altitude, is the counterpart of the Alma Range on the east—a base of Primary rocks capped with Tertiary sandstone. The beds of the "upper series" resting between those two ranges show much false bedding, and along the Hermitage Creek—under the flank of the thick quartzites—are distinctly inverted.

Stockyard Creek is the most southern point of the "lower group" in Dalkey. The rocks of the upper group seem to flank it on the east and south, while Tertiary deposits bound the western side. The channel of the Light from Hamley Bridge

to Redbanks show only a section of greatly faulted beds belonging to the "upper group."

SUMMARY.

To summarise the observations made on the two Primary groups, the whole district may be considered as formed of slates and sandstones (upper group), broken up on its western edge by upheaved limestones, slates, and quartzites. The varying dip and strike, great metamorphism and faultings, together with the presence of intrusive rock, characterising the "lower group," suggest that an immense period elapsed between the depositions of the "upper" and "lower" series. The lower group had been faulted and upheaved before the upper beds were deposited, and in the subsequent convulsions of nature the force which upheaved and faulted the whole country still further faulted the underlying limestone group.

The occurrence of the Tertiary sandstone capping the old Primary rocks is suggestive of its being a shallow water formation, and as a slow upheaval went on the products of denudation would necessarily gravitate into the lowest hollows —precisely as we now find them—and finally form the conglomerate beds so common in the different valleys. The eroding action of the watercourses have cut their channels through them where conditions were favourable, leaving the conglomerate beds in patches on the flanks or slopes of hills overlooking the valley. Where, then, a conglomerate patch exists above a watercourse, it bears silent testimony to the eroding influence of the stream below. Further than this, it testifies how very long a period has really elapsed since the dawn of what we still call "recent" geological time.

In the absence of palæontological evidence all identification of rocks based solely on their lithological features is open to a greater or less amount of doubt, but a faithfully recorded sequence of conformable strata in any one locality becomes a clue deserving consideration when examining neighbouring districts the topographical features of which suggest a relation thereto.

It has been shown that the upheaval of the western side of the Wakefield basin has had the effect of folding and faulting the beds of the upper group, producing the swells which by denudation of the softer portions now form the numerous parallel ranges extending northward. In the troughs of synclinal folds, or along the line of faults, the numerous creeks have worn deep channels, and owing to this circumstance, *i.e.*, the water following an indicated or ready-formed system of drainage, there are very few gorges or natural sections throughout the whole district.

What lies beneath the quartzites of the lower group is not visible in this district, but in the northern areas, at Tarcowie Springs, in the Appila Creek, a similar series of beds—which for the reasons just given I assume are identical with the Wakefield group—rest directly on mica schists, and both are pierced by a large dyke of porphyritic greenstone. The whole of the Pekina Range, extending as far north as Oladdie Station, seems identical in structure to the Wakefield basin—two unconformable series of beds, the one principally argillaceous, the other chiefly calcareous and siliceous. Between the Pekina and Wakefield beds lies the basin of the Broughton River, in which, according to Selwyn, the whole country is composed of one single series of rocks in anticlinal and synclinal undulations extending from Bundaleer to the foot of Mount Bryan. This series I have traced into direct connection with what I have termed the "upper group" in the foregoing pages, and despite the absence of fossil evidence the inference is a very strong one that the Pekina and Wakefield "lower group" rocks are identical. We have thus an axis of upheaval extending from the latitude of Port Augusta to the shores of St. Vincent Gulf quite distinct from that of the Hummocks and Mount Remarkable systems, and nearly on the central meridian line of the Flinders Range, when considered as a whole.

South of Kapunda the Adelaide chain has been so metamorphosed that lithological aspects on a large scale cannot be grouped in such a manner that the rocks shall of themselves bear the impress of identity, but the numerous references given by Selwyn indicate that the sequence of each conformable series will yet suffice to connect them with the two groups of the Wakefield basin.

EXPLANATION OF PLATE I.

The sectional line runs from Port Wakefield slightly north of east to the Murray Flats beyond Eudunda. From the Dalkey Range to the Hermitage Hill, the beds vary much in strike and dip and one bed is distinctly inverted. One mile east of Rhynie the faulted beds dip north-westerly, and the line of strike is only 25° from that of the section. The table-lands range is crossed at about 15° less than a right angle. All the other portions of the section are in the direction of the true dip or at right angles to the line of strike.—J. J. E.

Plants Collected in Central Australia,

Between lat. 22° 30′ and 28° S., and long. 136° 30′ and 139° 30′ E., by Ch. Winnecke, Esq., during his expedition in 1883; examined by Baron Ferd. von Mueller, K.C.M.G., M.D., Ph.D., F.R.S.

[*The following list was published in Mr. Winnecke's official report, but has received corrections from the author, and was ordered to be printed in the Transactions, by the Council of the Royal Society, December* 14, 1884:—]

Lepidium papillosum, *F. v. M.*
Erysimum Blennodia, *F. v. M.*
Capparis Mitchelli, *Lindley.*
Capparis lasiantha, *R. Brown.*
Drosera Indica, *Linné.*
Owenia acidula, *F. v. M.*
Bergia perennis, *F. v. M.*
Tribulus hystrix, *R. Brown.*
Zygophyllum Howittii, *F. v. M.* Petals about one-eighth inch long; filaments without appendages; anthers, when fully opened, almost roundish; radicle often three times as long as the cotyledons.
Erodium cygnorum, *Nees.*
Gossypium Australe, *F. v. M.*
Lavatera plebeja, *Sims.*
Abutilon leucopetalum, *F. v. M.* A variety with yellow petals of nearly two inches in length; some of the stamens fully as long; upper part of the styles exserted; fruit not seen. This plant offers an approach to A. exonemum, *Mons. Thozet*, sent from Muellersville, specimens with flowers fully three inches long.
Melhania incana, *Heyne.*
Seringea integrifolia, *F. v. M.*
Triumfetta Winneckeana, *F. v. M.* Leaves roundish or verging into an oval form, denticulated and somewhat crisp at the margin, velvety on both sides; sepals narrow, dorsally terminated by a minute conical appendage, petals downy towards the base; stamens numerous; ovary three-celled; fruit large, on slender stalklet, almost globular, indehiscent, thinly tomentose, copiously beset with long spreading bristle-like, nearly glabrous at the summit, hooked prickles. The nearest affinity of this plant is with T. leptacantha, but the fruits are much larger, and not glabrous; indeed,

they are in size similar to those of T. procumbens, but provided with longer and much more slender prickles. Leaves and flowers have been described from mere remnants adhering to the fruit.

Frankenia laevis, *Linné.*

Claytonia Balonnensis, *F. v. M.*

Atriplex leptocarpum, *F. v. M.*

Atriplex Muelleri, *Bentham*, var. lobaticarpa; dwarf, procumbent or ascendent, leaves small; fruit-bearing calyces minute, to the middle bivalved, digitate or flabellate, rhomboid, anteriorly cleft into five deltoid-semilameolar lobules, the lateral of which divergent or recurved, but often abbreviated, the lower portion of the fruit-calyx thickened towards the middle, but not appendiculated. This may possibly require specific separation, but the degree of variability of the group of saltbushes to which this plant belongs needs yet further to be studied in the field or from augmented museum material. The plant here under consideration reminds us also of A. fissivalve, from which it differs in less succulency, smaller leaves, less transparent, and less deeply valvate fruit-calyces, with shorter lobules without dorsal appendages.

Kochia triptera, *Bentham.*

Salsola kali, *Linné.* A variety of flowers and fruits crowded headlike on abbreviated branches; appendages of calyx minute.

Ptilotus latifolius, *R. Brown.*

Ptilotus alopecuroideus, *F. v. M.*

Ptilotus obovatus, *F. v. M.*

Polygonum plebejum, *R. Brown.*

Rumex crystallinus, *Lange.* Some of the plants only one inch high, though fully in fruit.

Macgregoria racemigera, *F. v. M.*

Isotropis Winneckei, *F. v. M.*, in Melb. Chemistry, Febr., 1884. An entirely new plant.

Crotalaria dissitiflora, *Bentham.*

Psoralea patens, *Lindley.*

Indigofera viscosa, *Lamarck.*

Swainsona laxa, *R. Brown.* A variety with somewhat larger flowers; lobes of the calyx considerably shorter than the tube, the two upper rather blunt; lateral petals dark violet-coloured towards the summit; stipe of pod slightly longer than the calyx.

Glycine sericea, *Bentham.* Reminds of Galactia tenuiflora.

Petalostylis labicheoides, *R. Brown.*

Bauhinia Leichardtii, *F. v M.*, var. cinerascens. In this singular variety the rust-coloured silky vestiture of the

calyces and petals is replaced by a thin dull-greyish tomentum. The same form has been obtained on Julia Creek, a tributary of the Flinders River, by Mr. Armit; there particularly the petals become glabrescent. The leaflets are narrower than usual. Fruit for further comparison is not available. The far extratropic Bauhinia of Cooper's Creek is B. Carronii.

Neptunia gracilis, *Bentham.*

Acacia dictyophleba, *F. v. M.* Young pod broad linear, viscid, straight, flat, not hairy, somewhat thickened at the margin; stipe short.

Calycothrix longiflora, *F. v. M.* This has recently been also collected within the limits of New South Wales, near the Warrego, by Mr. Betche.

Melaleuca glomerata, *F. v. M.* Flowers small; tube of calyx thin-velvety, lobes short and blunt; petals tender-membranous, almost colourless, ciliolated, otherwise glabrous; stamens, when dry, pale yellowish, five to seven in each bundle; the connate portion about as long as the petals, but much shorter than the free portions of the filaments.

Eucalyptus gamophylla, *F. v. M.* On the specimens now collected the upper leaves become narrow lanceolar, continuing opposite or getting scattered.

Eucalyptus microtheca, *F. v. M.*

Lythrum hyssopifolium, *Linné.*

Ammannia multiflora, *Roxburgh.*

Haloragis Gossei, *F. v. M.*

Didiscus glaucifolius, *F. v. M.*

Pimelea simplex, *F. v. M.*

Loranthus Quandang, *Lindley.*

Melothria Maderaspatana, *Cogniaux.*

Pomax umbellata, *Soländer.*

Oldenlandia tillæacea, *F. v. M.*

Dentella repens, *Forster.*

Calotis cymbacantha, *F. v. M.*

Calotis lappulacea, *Bentham.*

Vittadinia Australis, *Richard.* Fruit specimens only two inches high.

Pterigeron adscendens, *Bentham.* A dwarf form, with larger ligules of the ray-florets.

Epaltes Australis, *Lessing.*

Myriocephalus Rudallii, *F. v. M.*

Myriocephalus Stuartii, *Bentham.*

Helipterum floribundum, *Candolle.*

Gnaphalium luteo-album, *Linné.*

Senecio Gregorii, *F. v. M.*

Wahlenbergia gracilis, *A. de Candolle.*

Isotoma petræa, *F. v. M.*
Brunonia Australis, *Smith.*
Erythræa Australis, *R. Brown.*
Duboisia Hopwoodii, *F. v. M.*
Solanum oligacanthum, *F. v. M.*
Nicotiana suaveolens, *Lehmann.* The flowers in some of the specimens less than an inch long.
Stemodia Morgania, *F. v. M.*
Justicia procumbens, *Linné.*
Ipomœa Muelleri, *Bentham.*
Cynanchum floribundum, *R. Brown.*
Pollichia Zeilanica, *F. v. M.*
Halgania cyanea, *Lindley.*
Heliotropium filaginoides, *Bentham.*
Teucrium racemosum, *R. Brown.*
Clerodendrum floribundum, *R. Brown.*
Newcastlia spodiotricha, *F. v. M.* Found also by Mr. Kayser at Eyre's Creek; by Mr. Giles, near the Alfred and Mary Range; and lately near Mount Everard. Corolla deep blue.
Dicrastylis Dorani, *F. v. M.*, var. eriantha; leaves narrower, conspicuously tomentose; glomerules of flowers two or more superposed along the stalks; calyces involved in a dense woolly vestiture; corolla as in the normal form, almost bell-shaped, its tube short and turgid, the lobes obtuse. The Rev. H. Kemp sent a small-leaved variety from the Finke River.
Dicrastylis Lewellini, *F. v. M.* Tube of the corolla cylindrical, longer than the rather acute lobes; the fifth stamen between the two smaller corolla-lobes often altogether wanting, but sometimes developed and quite perfect. This and other rare plants brought by Mr. Winnecke extend probably along sandy tracts of country into Queensland territory.
Eremophila Macdonnellii, *F. v. M.*
Eremophila Willsii, *F. v. M.* A variety with branches and leaves glabrous.
Eragrostis speciosa, *Steudel.* Fully in flower at less than six inches in height.
Aristida stipoides, *R. Brown.*

Remarks on some Indigenous Shrubs of South Australia suitable for Cultivation as Fodder.

By Samuel Dixon.

[Read February 5, 1885.]

In considering some of the fodder plants of South Australia, instead of drawing your attention to the herbs and grasses, which are popularly looked upon as comprising our only stock foods, I am desirous of making some practical remarks upon a number of plants, usually shrubs or small trees, which constitute a most important part of the food of sheep and cattle, especially in the drier and more arid portions of this colony, some of which are to be found widely spread through northern districts, and extending to our eastern and western boundaries. The subject cannot be exhausted in one evening, but I feel that in view of its great importance to the well-being of the colony I may by bringing it under the notice of the Royal Society of South Australia assist in spreading a knowledge of the advantages of preserving, cultivating, and increasing the growth of a class of stock food which suffers but slightly from droughts, and which by its abundance adds greatly to the numbers of stock depasturing in certain areas, and by providing a constant supply of wholesome food promotes the growth and quality of that wool which is our chief export; and finally, adds so much flavour and sweetness to our mutton. It seems very desirable that many of these plants should be extensively cultivated, as their foliage becomes available when the grass is either gone or has lost all its nutritious qualities. In the large estates used solely as sheep-walks, lying mostly to the north of Adelaide, if belts of these native shrubs were laid out and the sheep only admitted during the months of April, May, June, and July, I am convinced the condition of the sheep would be better maintained, and consequently the growth of wool sounder and more abundant; the percentage of lambs would be higher, and in the long run more stock would be carried on the same area.

The study of shrubs edible for stock is one of the very greatest practical importance not only to the sheep farmer, but to all dependent on him in business; the presence or absence of certain of them renders the occupation of large tracts of country profitable or the reverse, and an adequate knowledge of them is of the first importance. At present very few of

those whose interests are bound up with stock can either name correctly or accurately describe the plants on which they indirectly subsist, although everywhere in Australia amongst practical men certain prevalent forms of vegetation give a name to well-understood sorts of country; for besides the general distinction of grass country or saltbush country we have in each of the colonies familiar expressions roughly denoting the healthiness or otherwise of certain areas, such as the "jam" country of West Australia, named from an acacia whose wood is scented like raspberry jam; or again, in New South Wales, another acacia, the "myall," with violet-scented wood, is a certain sign of the healthiness of certain districts; or in our own colony, "mulga" country defines certain peculiarities of soil and climate.

Very heavy losses have arisen from sheep farmers being misled as to the food qualities of the scrubby vegetation. For instance, many of the scrubby plants of the Murray Scrub are excellent fodder; others, characteristic of the South-East and Kangaroo Island, are so deficient in nutriment that sheep can barely exist, as they are mainly Hakeas, Grevilleas, Melaleucas, Banksias, &c., whereas the shrubs to which your attention is to be directed greatly assist in producing that excess of stearine in tallow which is the main cause of stock retaining their fat during long journeys, and this excess of stearine is conspicuous in cattle fattened amidst the saltbush and mulga of the North. But, on the contrary, the deficiency of stearine in stock fattened in the South-East is the reason why they "waste," or in other words, lose condition so much before reaching the Adelaide market.

It is the more desirable to consider this subject, because I fear that in some localities many of the most valuable of our shrubs are doomed to extinction from the fondness of stock for them and from that system of overstocking which too commonly prevails, and because in some localities—as, for instance, from the east bank of the Murray River to the Victoria border—the rabbits are barking and completely destroying all those shrubs which gave that region its chief value as a grazing country; and as the seasons when sufficient rains fall to give a good growth of grass are very irregular and uncertain, a vast area is likely to become more or less a real desert.

It is also noteworthy that stock do NOT in different localities invariably eat the same plants; of this, the Native or Cypress Pine (*Callitris verrucosa*) is a striking instance. On the Murray and in the North it is greedily eaten wherever stock can reach it, but on the western slopes of the dividing range in New South Wales and to the south-east of Cobar, the same tree becomes a real pest to stockholders, for, seeding very abundantly,

a dense growth of young pines prevents grass from growing; and there is not grass enough to carry fires through the country, as was the case before the country was stocked, and the result is that land there is now much less profitable to occupy.

The leading characteristics of our vegetation are peculiarly adapted to the arid zone it occupies, and which for fodder plants capable of withstanding protracted droughts is, I suppose, the richest in the world. Compared with South Africa, I can personally testify to its great superiority; and in the corresponding zone in North America the census of fodder plants is also much smaller, while in South America the cactus family (few of which are edible) too largely prevails.

To conclude these preliminary remarks, permit me to acknowledge very gratefully the kind assistance of Prof. Tate in lending specimens and in furnishing me with the scientific names necessary to identify plants, many of which, so far, have no common name, but where one exists I gladly use it; and finally, my only title to address members of this Society arises from a close practical observation continued for many years over large areas of this and the adjoining colonies.

I propose to mention first those plants which are common around Adelaide and in our moister climates, and afterwards to describe those belonging to more arid regions, but which are well worthy of cultivation wherever they will grow.

Bursaria spinosa.—A very common bush, named from the supposed likeness of its heart-shaped seed vessels to the pods of Shepherds' Purse, and from a few thorny spines much better deserves its second name. The flowers are small and white, in large pinnacles, and most abundant during summer. In the South-East it grows to be a small tree with larger leaves (and without spines) than is ever found this side of the Murray. Sheep eat it as soon as the grasses dry up, and where abundant makes a good "stand-by," and is of great value in late seasons. Its spines prevent its being eaten out like the last described. It stands pruning well, and would be serviceable as an ornamental hedge to cottage gardens.

Pomaderris racemosa.—This is another common bush in the moister districts, and seldom exceeds two feet in height, with an abundant foliage of smallish roundish leaves. The flowers are inconspicuous in small clusters, and the leaves when chewed or soaked are found to be slightly mucilaginous; this explains the fondness sheep have for this plant. It always seems fresh and green, and stands stocking well.

Pittosporum phyllæroides.—A small tree, with whitish bark, and drooping foliage of narrow leaves; flowers small and

scented; seed vessel before opening is oval, and of a bright orange colour, highly resinous, and its flavour is most disagreeable; but sheep are exceedingly partial to its foliage, and when one succeeds in pulling down a branch the rest make a rush to partake of such a dainty, and owing to this the tree itself is like to be exterminated, although originally very common in the limestones of Port Lincoln and the Murray. Were this cultivated, and sheep only admitted occasionally to the enclosures, it would never reach a troublesome height. Like most of its family, it is easily raised from seed.

Casuarina quadrivalvis.—The Sheaoak so common around Adelaide. All stock devour this tree, and in Port Lincoln the fallen catkins (male infloresence) form the chief sustenance in winter on much of the overstocked country. In many parts the ground, if fenced off, is quickly covered with the young trees, and if after the third year the sheep were admitted only during the winter they would be prevented from growing too high. It is too sour to be very useful to ewes rearing lambs, but if sheep only had enough of it, the "brake," or tenderness of fibre, would often be prevented in our finer wool districts, and much money saved by the increased value a sound staple always commands.

Acacias.—The Wattles of various sorts are common almost everywhere. The common or Golden Wattle, *A. pycnantha*, is now being extensively cultivated for its bark; for grazing, however, its value is not so well recognised, but I am of opinion that in winter its value as an astringent is very great, as sheep often suffer from a diahorrea caused by eating frozen grass, and if access be provided to any of the varieties of Wattle this is prevented, and the improved clip will repay the woolgrower the extra trouble of cultivating this ornamental and beautiful tree.

Acacia melanoxylon. — The Blackwood, which is confined with us to the South-East and our cooler southern valleys, is of more use for its timber (which is one of the handsomest furniture woods in Australia), than for its foliage, which, although eaten by cattle and sheep, is not of the greatest value; but the contrary is the case with the mulga, *Acacia aneura*, a shrubby tree of the very greatest importance in Central Australia, where it covers large areas, sub-varieties of which there are many, being somewhat difficult to define, varying a little according to the locality. The stony ranges, the rich red loamy plain, and the sandhill country have each a mulga differing mostly in the size of the leaves and position of the branches, and recognised by the aborigines under distinctive names, the typical mulga having numerous branches at nearly right

angles to the main stem. The narrow leaves are comparatively veinless—hence its specific name—and the flowers growing singly are of oblong shape, instead of spherical, like *A. pycnantha*. Its most remarkable characteristic, however, is the mucilaginous quality of its foliage, a leaf, when chewed, yielding a distinct flavour of gum, and without that astringent taste so common in Acacias grown in the moister regions. The presence of mulga in sufficient quantities is of the first importance in runs situated in the more arid portions of Australia as being not only the best stand-by, but as furnishing posts for fencing, the timber being very close-grained, hard, and lasting. As to how long the timber (generally of small size) will remain in the ground without decaying it is very difficult even to guess at, for it frequently happens that old forests of it are found standing evidently killed by fire, amidst a growth of young trees, which must have taken many years to grow to their present size, for the mulga is a very slow grower, but if cultivated in a moister climate I think would grow more rapidly, and yield a less scanty foliage. Amongst stockmen it has an evil reputation, as wounds caused by riding through scrubs of it often fester, and are difficult to heal. The most southern limit of it that I am aware of is at Anabama, some 90 miles from the Burra, on what is well known as the Pegline, the surveyed road to the Darling. It has been used extensively for smelting at Cobar, and exists around Silverton, and no doubt its close-grained charcoal will be very useful in reducing the silver ores there.

With the view of getting precise and reliable information as to the properties of the scrub in question, a sample of it was forwarded to Mr. William Johnson, the analytical chemist for the Victorian Government, who further submitted it to Baron von Mueller, the Victorian Government botanist, and it affords me considerable satisfaction to give you an extract from the report of Mr. Johnson as to the value of mulga: — "Examined chemically, it has been found to contain a large quantity of starch and gum, together with albuminous bodies and other constituents common to all vegetables. It is destitute of any poisonous properties, and, viewed as an article of food, must be very nutritious to all animals eating it. The mineral constituents amount to two per cent., and consist of carbonates of lime and potash, together with sulphates and chlorides, all very useful in the animal economy." Baron von Mueller's report is purely confirmatory of the above, and need not be repeated.

Acacia salicina—The Broughton Willow, as it is called in the North, being found mainly on the River Broughton and its tributaries. A very handsome little tree with drooping

branches; a good deal eaten by sheep and cattle. It resembles some of the drooping myalls of New South Wales; its seed-pods long and narrow, each seed being surrounded by a velvet-like thread or aril of a deep red orange colour; like most of the family, its seeds germinate more surely and quickly by being soaked in boiling hot water. The procession caterpillar destroys many trees by eating off the foliage, and the singular silk bag filled with the exuviæ of this destructive insect are to be found hanging in large numbers on the trees. *A. Oswaldi*, found on the Murray, is much less handsome, but is also eaten by stock.

Cassia eremophila.—A pretty little shrub with three small leaflets on each side the leafstalk, flowering abundantly in the Spring; the flowers bright yellow, scented, and nearly half an inch across; easily propagated, and both pods and leaves eaten by sheep; is widely spread in dry regions.

Cassia phyllodinea.—This species is named from its leaves being merely flattened phyllodes, and these are bifid at the extremity. This is inedible, excepting the pods when green, and is a nuisance in spreading over the warm loamy soil of the Lower Darling and similar country here; but, unlike the foregoing, grass will not grow beneath it, and is mentioned to prevent its being grown in error.

Cassia artemisioides.—This is one of the handsomest of the tribe, and is worthy of being cultivated for its very showy yellow blossoms.

Templetonia retusa.—Another showy leguminous plant, which is not uncommon on limestone soils near the sea, but grows very freely on deep, rich, red soils. Its large red pea flowers are abundantly produced, and sheep devour the green pods and the leaves also; it is easily raised from seed, and not growing too high, and the branches being close and the foliage abundant, would be useful also as a "breakwind" on exposed plains. A very handsome dark-flowered variety is common on the Flinders Range. The specimen came from the Port Germein Pass.

Myoporum platycarpum.—The so-called Sandalwood of the Murray, and is common in dry limestone soil throughout the less humid parts of the colony. Its leaves seem to be eagerly eaten by sheep when they can reach them; but the tree generally grows from 20 to 30 feet high, and is often felled for sheep when long droughts prevail. If the branches are lopped off the tree soon starts a fresh growth, and by the time another drought comes has often a sufficient growth to again bear lopping. It is often wantonly destroyed, and should be protected by regulation. It is a very elegant tree, having quan-

tities of small white blossoms in January or February, and is well worth growing as a "stand-by." Had the City Gardener planted this tree in the North Adelaide Park Lands, on the limestone soil, the result would have proved much better than planting red gum, elms, &c., which can only have a miserable existence before they finally die off. The timber has a pleasant scent when burned, but if used as posts, is liable to be eaten and destroyed by beetles.

Santalum acuminatum.—The Quondong, or Native Peach, belongs to the real Sandalwoods, and is one of those shrubs which soon disappears with heavy stocking. Cattle breaking it down, and sheep eating off the shoots soon kill the trees, and young ones are very few and far between ; in fact, from my observation, I believe that to be swallowed by the emu is almost necessary for the germination of its well-known seed. I can hardly recommend it for general purposes as a fodder plant to be cultivated, for, although its foliage is very nutritious, the plant seems too tender except in rich moist nooks. Its very light green leaves have a yellowish tint, which in shrubberies would form a good contrast, and when covered with fruit of the brilliant shiny crimson so well known to bushmen is a very striking object in the dull green usually around.

Eremophila longifolia.—The Dogwood of bushmen, and named by them from the offensive smell which the leaves have when crushed. The tree itself is not uncommon, and may be known by its woody seed vessel, covered by a black shiny skin; by its dull red blossoms, nearly two inches long; and drooping leaves three to four feet long. It likes deep rich soil. Sheep are exceedingly fond of its foliage, and they are apt to eat even the twigs, so that when grown it is necessary sheep should only have occasional access to it. It is one of the first to be barked by rabbits. Another species, *E. Brownii*, has a bright scarlet-coloured flower, but the foliage is too scanty to render the plant worth attention. It was common on the hard limestones of Port Lincoln, but is now much scarcer there.

Geijera parvifolia.—The Sheep Bush. Sheep only are particularly fond of this bush, which grows on hard limestone soils, and seems quite unaffected by droughts. It seldom grows more than ten feet high, and has a number of small stems from the crown of the roots. You will always find every leaf eaten off within reach of sheep, who eat it at all seasons. The seed vessel always contains two small shiny black seeds, ripening at the end of summer. The dense growth of this shrub gives a good deal of shelter, and in its native state affords the kangaroo shelter from the sun. I should like to see this shrub established on all sheep farms. The specimen came from Telowie. It ought never to be destroyed wantonly.

Nephelium oleæfolium (v. Mueller).—*Heterodendron oleæfolium* (p. 124, "Native Plants of Victoria").—This small tree is also common, and the bitter taste of its dull grey leaves resembles quinine. Both sheep and cattle feed very greedily on this little tree, but as soon as stock are removed from the paddocks it is one of the first to recover, throwing out fresh leaves, and like the last described is of very great value in dry seasons. I have seen it as far south as the Government Farm, Roseworthy, but in the Bourke district of New South Wales are the largest specimens I have seen, the rich, warm, loamy soil seeming to suit it exceptionally well; the increased size and dense foliage giving a welcome shelter from the sun. Judging, too, from the bitter flavour it is likely to be of use in medicine, and I hope some of your learned members of the medical profession may be induced to experiment with it. It cannot be too frequently grown.

Leptomeria aphylla.—This stiff, awkward-looking shrub is well described as *aphylla*, only the very youngest shoots showing traces of anything like leaves; in fact, the shrub resembles a parcel of green sticks and small stiff twigs. It is by no means ornamental, and its small red fruits, with a little green knob at the end, are too inconspicuous to attract attention. Sheep, however, find it pleasant to browse on, and in doing so often fill the wool on the top of the neck with its small twigs. I can hardly recommend the cultivation of this queer-looking shrub, but it should never be destroyed where it grows naturally.

Exocarpos cupressiformis. (The Native Cherry).—This very handsome tree is a favourite food with sheep and cattle, and a young tree is consequently somewhat uncommon. If it can be readily grown, however, there is no doubt of its desirability, but as it likes rich soil and a cool climate, I do not expect it will be used as a fodder-plant generally.

Gossypium Sturtii.—This very showy summer-flowering shrub, named after the gallant explorer, Colonel Sturt, is a native of the glens of the mountain ranges of the interior. It grows very freely in gardens around Adelaide, is very easily propagated, and affords stock a good summer feed; and is as handsome in pleasure grounds as it is useful as a sheep and cattle food. It is a suitable plant for gardeners to cultivate, and likes a fairly rich soil, and when cut down (if not too close to the ground) sends out plenty of young shoots. Its absence from the city Park Lands is a good specimen of their general mismanagement, and how little native shrubs are appreciated.

Sida petrophila.—This showy little plant is well named *petrophila*, or rock-loving, being most common on the top of all northern ranges in the saltbush country. The disc-like yellow

blossoms and downy grey-green leaves render it very conspicuous, although it does not much exceed three feet high, and, like other plants affecting the same situations, flowering after copious rains. There should be no difficulty in growing it commonly, but it does not like too moist a situation. It seems to be as much liked by sheep as by marsupials, and I have seen large tracts quite cleared by their united efforts.

Dodonæa viscosa.—The native Hop Bush, and one of the largest of the Dodoneas growing here. Its chief use as a fodder plant is in the "hops," as bushmen call the four, round, winged seed vessel, each section of which contains a little black seed. It produces large quantities of seeds, and during November and December, until its coppery-red seed vessels get too dry, sheep and cattle eat them eagerly. The foliage is resinous, and to see the bush eaten down is a sure sign of "hard times" with the sheep. It is sometimes twelve feet high or more, and likes warm, red, sandy ground. In the old times when shepherds were kept to look after sheep, the hutkeepers used the "hops" as a substitute for the real hop in making sugar-beer and to make yeast for bread. It is very suitable for cultivation in shrubberies.

Lycium australe.—This is a very useful fodder plant indeed. It grows up to four feet in height, and is thickly covered with short oblong juicy leaves. Drought never seems to affect it, and having many spiny points, sheep can never quite eat it out. It is also one of the very few shrubs in saltbush country which throw out abundant suckers. The flower is small, lilac-white, and salvia-shaped; the fruit is also small, bright red, and of a sweetish tomato flavour. The shrub is abundant nearly everywhere, and is often recklessly destroyed by farmers in their attempts to grow wheat in unsuitable places. I believe it to be very fattening, and likes saline soils.

Zygophyllum fruticulosum.—This small shrub is very common in calcareous soils and sandhills. It has small juicy linear leaflets in pairs. The seed vessels resemble in shape and size the *Dodonæa* above described. It has an abundance of single yellow flowers, and on Yorke's Peninsula, around Wallaroo, it grows very plentifully on long fallowed ground. It is also common among the mallee scrubs, and sheep, feeding where it is common, care less for water, finding abundance of moisture in its singular leaves. From a letter of Baron Sir F. v. Mueller to Prof. R. Tate it appears that the *Zygophyllum* family is poisonous in South Africa, and certainly I have had reason to suspect *Z. glaucesens* of killing sheep, but have never had the opportunity of testing it. I am, however, very confident that *Z. fruticulosum* is not injurious, for although not universally and at all

seasons eaten by sheep, it is quite eaten out in the Murray River scrubs, and I never knew any ill-effects produced by it. The other *Zygophyllums* are seldom or never eaten by sheep.

Goodia medicaginea.—This handsome shrub will grow to four or five feet high, or even higher, and retains its foliage throughout the year, having a preference for limestone soils, and flowers during September and October; produces an abundance of seeds in short pods. Horses, cattle, and sheep devour it greedily, but of late years I have seldom seen it. The specimen was gathered near the Duck Ponds, Port Lincoln, inside a fenced-off piece of road, otherwise, no doubt, it too would have disappeared by being eaten out. Some allied species are poisonous, but I have never known injurious results from eating this one. Baron von Mueller, in the letter above-mentioned, also states that, in Gippsland, *Goodia latifolia* has been proved to have poisoned cattle. It would be interesting to know for certain whether the poison exists in the seeds or leaves. It often happens that a good deal of obscurity exists about poisonous plants and their effects, as they seem very uncertain. A friend of mine lately fed some old ewes on the undoubtedly poisonous *Euphorbia Drummondi*, but could not kill them, although he often loses an odd sheep or two from poison, and no other known poisonous plant exists on his property. I am inclined to believe that many leguminous plants reputed to be poisonous are not really so, but that an excess of either foliage or seeds eaten by a hungry animal throws off such an abundance of gases that "hoove," which is nothing more than an excessive distension of the stomach pressing against the diaphragm, preventing the lungs from working, and the animal is really strangled to death. To this cause I attribute all the deaths (and they are very numerous) caused by *Lotus australis var. Behrii;* really an excellent fodder plant, akin to the lucernes, but when seeding, and especially after rain, if hungry sheep are allowed to feed greedily upon it they die by hundreds, while sheep in confinement and fed solely on it do not die but actually thrive, as was proved some years since in Adelaide.

Kochia aphylla.—The Cotton Bush, so well-known and of such vast importance to herds and flocks in all our dry and very arid country. It belongs to the real saltbush order, and not like the two last described, which are only popularly considered so. It derives its popular name from the white cotton-like balls, the effects of a gall insect, very conspicuous indeed on a plant which so well deserves its scientific name of *aphylla* (without leaves), or sometimes present as mere scales. The plant usually presents the appearance of a round heap of reticulated green wiry twigs. It is most common on red clays and loams, espe-

cially where liable to occasional floods, and in the immense plains of the interior is a most reliable sign of those watercourses which, as they only become such at very long intervals, could hardly be traced but for this singular plant. Petals it has not, but the calyx is five-lobed, with a broad horizontal connate membrane. All kinds of stock are often largely dependent on it during protracted droughts, and when neither grass nor hay are obtainable I have known the whole bush chopped up and mixed with a little corn, when it proved an excellent fodder for horses. One drawback it has: its stems being very fibrous, and the older portions indigestibly so, it is the principal cause of those bezoars or felted knobs in the maniplus of the sheep, which in very protracted droughts kill them by hundreds. When, however, the rains come, and soft herbage is abundant, these bezoars either partially dissolve or become covered with a shiny-black coating, so that they then resemble a "papier-mache" ball. I believe the Cotton Bush attains a great age, and have often observed the extreme distance its fibrous roots spread. This is another of those plants which should never be ploughed up. As far as I have observed it does not commonly grow again, and has a greater value in its native habitat than anything which can permanently be grown there, and apparently does not seed freely.

Kochia sedifolia and *K. villosa*.—Commonly known as Blue Bushes. These grow on very healthy sound sheep country, but are not themselves good fodder plants. As a matter of fact, should they be eaten, the sheep must have suffered a good deal of starvation, and if they are eaten out, you may be certain sheep must have died in numbers. Before leaving *Kochia villosa*, it may be remarked that Baron von Mueller looks upon the Cotton Bush *(aphylla)* as merely a variety; but this is a case where we may look upon the sheep as a better botanist than ourselves, as both *K. villosa* and *sedifolia* seem to be very distasteful to them, and while we admit the exact similarity of the horny flower and fruit, I do think the extraordinary length of the roots of the Cotton Bush, as well as its difference in everything except the flowers and fruit, should entitle it to a distinct and separate position, and allowing this, I have observed two sorts growing near together mostly distinguished by the difference in the shade of their green stems, and in this case too sheep make a difference between them. Around Forbes, in New South Wales, I have seen another variety of *aphylla*; its young shoots drooped, were of a lighter green, and the small leaves or bracts more abundant.

Rhagodia parabolica.—This is another saltbush, which produces a good deal of foliage, and is not uncommon. Generally

found forming a low bush around some bigger tree; I have noticed it especially with *Leptomeria*. It is worth attention for cultivation. *R. spinescens*.—The same remarks apply to this species of saltbush also.

Chenopodium microphyllum.—A saltbush, like the preceding, often found protected by some larger shrub, and sheep care more for it than for many other saltbushes. It would be useful if growing freely; but experience must prove the best guide, as I think it possible some of the saltbushes will prove difficult to grow out of their own special localities.

Atriplex vesicaria.—This is one of the most common and widely-diffused of saltbushes, and is sometimes called the Small White Saltbush. This, I think, can readily be grown wherever the climate is not too wet. It covers very large extents of clayey plains, and in good seasons is only nibbled at by stock, excepting when covered by those curious vesicles which give name to the species. There is an annual sort much resembling it which unfortunately I have failed to determine the precise name, but the tops of the young plants are fairly edible when boiled, and together with *Tetragonia expansa*, or Native Spinach, have often afforded me a change of diet in the outside country. Before the vesicular seed vessels are quite ripe they make quite a loud report if trodden under foot.

Atriplex nummularium.—Often called the "Cabbage" Saltbush, from the comparatively large size of its leaves. It grows to over eight feet high, and is found commonly near to where water lies for some time; also on flats bordering the Murray that are rarely flooded. Eaten by sheep when food is scarce, not difficult to grow from seed, and adapted to form a contrast in shrubberies from having scaly grey leaves, and forms a dense bush.

Atriplex paludosum. — This saltbush is named from its favourite habitat, and may be readily distinguished from *A. vesicaria*, the leaves being much narrower and more erect. I mention it mainly to point out that not all the saltbushes are edible. This one in particular stock never eat if anything else is to be had.

Rhagodia Billardieri.—This small shrub is a very useful fodder plant, much eaten by sheep, although the branches are spinescent. It is mostly found on rich ground liable to floods, and is not very common here, although very abundant on the River Darling. From its habitat being restricted to flooded ground I do not think it worth cultivating. It should never be ploughed up, but, like all other of the best of the shrubs of which I have treated, it is imperative that sheep should not be kept constantly where it occurs.

Sarcostemma australe.—A very singular plant, named by Robt. Brown, the great botanist of Flinders' voyages, and described by him as a trailing twiner, but as found here it is a leafless mass of rigid stems three to four feet high, somewhat glaucose, scarcely so thick as a penholder. The stems, if broken, exude an acrid milky juice, but on the stony table-lands of the north-western district sheep have lived on this plant for months without water, and kept up their condition. The aborigines are also said to use it to prevent ulcerous sores from spreading. Like many more of the foregoing, injudicious stocking causes its complete destruction. In fact, all over Australia, wherever bushes of similar character to those described in this paper predominate, the extreme unwisdom of overstocking is most alarmingly evident, and each succeeding drought makes matters worse. The necessity felt by the sheep farmer to recoup heavy losses prevents his run being so lightly stocked as to permit of the young plants becoming established, with the result that each succeeding drought is more severely felt.

In concluding these remarks I hope some abler observer of plant life in the interior may publish notes, not only on our unsurpassed and exceedingly valuable grasses, which withstand drought in so remarkable a manner, but also on those very fattening herbs which cannot be surpassed in the whole world for their property of forming fat very rapidly, and of such a quality that stock travel enormous distances to market, and waste so slightly as to be able to surpass stock fattened locally. One such herb is that deliciously-scented clover, *Trigonella suavissima*, or Menindie Clover, which grows on soils subjected to lengthened inundations, such as Menindie Lake, and another is that useful vegetable *Tetragonia expansa*, or Native Spinach, very often boiled when garden-grown vegetables are scarce, and very many others, some of which may become of great use when cultivated beyond their natural limits.

It is very much to be desired that some one may also point out those plants, natives of the heated interior, which are likely to grow in the settled districts during summer, as I think it may be possible to sow with the seed-wheat annual grasses or succulent herbs which would grow during the hot weather, and after the grain is reaped. The immense advantage this would afford needs no enlarging upon; it would double the stock-feeding capacities of our farms, and I hope experiments in this direction by the able Professor of Agriculture at Roseworthy may be undertaken, as promising results of the greatest practical importance to all districts of the colony.

Boerhaavia diffusa.—In *Boerhaavia diffusa* we have one such plant—a perennial of straggling habit, with juicy leaves, often

lanceolar in shape, and when fading the underside has a characteristic pink hue. The Field Naturalists' Section found it near Noarlunga last summer. All sorts of stock feed upon it, and its trailing stems are found on many of the sandhills in central regions.

Claytonia Balonnensis.—This showy plant, called "Munyeroo" by the aboriginals, derives its secondary scientific name from the Balonne River, Queensland. It has a cluster of thick fleshy leaves, with a flower stem some six or more inches high, crowned with bright deep pink flowers as large as a shilling. Half an inch of rain, and it rapidly covers the sandhills. Cattle then leave the waters and feed on it, going without a drink for weeks together, and recently a large mob of cattle, destined to stock a Northern Territory run, travelled some 200 miles without a drink—a truly wonderful journey—and without this succulent herb altogether impossible. It is highly esteemed by bushmen and aborigines, and eaten either raw or cooked. Many others of the Central Australian vegetation are very interesting, and will repay a careful study, and some may possibly prove adapted for cultivation. One succulent plant, *Portulaca oleracea*, common to Europe, Asia, and Australia, may be found as a weed in our gardens, and is a useful sheep food in central regions, where its rounded, fleshy, jointed stems trailing close to the sand seem to luxuriate in heat, and to find the scantiest rain sufficient to give it vigorous growth.

In closing these very sketchy remarks, it may be hoped that as a knowledge of our native vegetation spreads, much advantage will result to the colony; for if our indigenous fodder plants are preserved, instead of being recklessly and wantonly destroyed, more good will result than by afterwards endeavouring to introduce new plants from similar climates, although in this direction also there is an immense field open of the most promising description, but as far as experiments have yet gone nothing exceeds, in practical use, our own native flora.

Notes on Iridescent Clouds.

By W. A. Jones.

[Read May 5, 1885.]

In some of the scientific journals attention has been lately drawn to the phenomenon of iridescence in clouds in daytime. The mass of correspondence on the subject may be assumed to have been started by the great amount of interest lately excited all over the world by the beautiful sunrises and sunsets, with the accompanying theories which have been propounded to account for them.

There has thus been a large amount of contemporaneous observation lately directed towards all meteorological peculiarities. Many of the observers have seen things new to them, and have recorded their observations as original, whilst in some cases the appearances observed have been misnamed, and the term "iridescent clouds" has been frequently applied to tints belonging to an entirely different class of sky colours.

I shall endeavour to show by evidence that the appearances which some observers have referred to unusual conditions are not new or unusual, but that they have been observed a long time past, and are of frequent occurrence, though they often escape detection.

It will be seen from the descriptions by others and myself that the clouds under notice are similar to those observed by Herschel in 1841, and described in his meteorology. I shall quote Herschel first. He says:—"The clouds were tinged with bands of colour, not in circular form around the sun, but following the sinuosities of the clouds. The colours commenced from the white area forming the interior, and proceeding outwards to the edge, were—1st, white; 2nd, very pale pink; 3rd, blue green; 4th, at the edge, purplish pink. These colours obviously had no reference to the greater or less proximity of the clouds to the sun, but depended upon the thickness of the cloud or the length of the path within it traversed by the visible rays. After watching for some time the bands grew broader and the tints stronger, with a tendency to form a corona. It seems impossible to regard these colours otherwise than as the resultants of the superposition of a series of interference fringes following a regular progression of breadth (due to a progressively increasing size of the drops) from the exterior to the interior of the clouds."

Similar clouds to these were observed and recorded at the

University Observatory, Christiania, in 1871, February 22nd, March 1st, May 10th; 1874, January 13th; 1875, February 17th; 1882, January 11th, February 22nd, July 13th; 1884, December 8th, 9th, 10th, and 12th.

The following is an extract from the observations of Christiania, January 11, 1882:—"At 3.30 p.m., sun having set at 3.20, extremely beautiful cirro-stratus iridescent clouds in south-west, at an altitude of 8° to 12° were seen. The upper borders, and later on the lower borders, were red, with yellow brims, the red of the borders and the inner parts were variegated, and very variable, resembling the red light commonly seen in mother-of-pearl. This changed through crimson into blue-green, and then into grass-green. The most striking cases of the phenomenon have been observed here when mild and dry weather set in after frost."

The extracts from my own notes also show that these clouds occur frequently. Thus:—

"In 1884, June 12, D.B., 78°; W.B., 67°; iridescent* clouds, and fine glow.

"June 15, D.B., 83°; W.B., 56°; iridescent clouds, beautifully tinted.

"In 1885, January 16, D.B., 80°; W.B., 61°; edges of clouds tinted pink, with green farther in. The red extended beyond the edge, like the red glow seen above the horizon; clouds of a heavy cumulus kind.

"January 26, D.B., 70°; W.B., 58°; iridescent clouds, very fine, all being high cirro-cumulus.

"January 28, D.B., 71°; W.B., 55°; barometer falling, very short glow in morning, faint clouds, and an ice-cloud halo visible nearly all day; the green very bright; clouds were very high cirro-films. Iridescent clouds seen about 10 a.m., just before halo formed.

"January 30, D.B., 80°; W.B., 60°; iridescent clouds like Herschel's present. The light appeared to be polarised in planes tangential to the sun; colours very varied. A fine pink halo existed round the sun.

"February 21st, D.B., 71°; W.B., 62°; clouds rather high, clearing off towards noon; beautiful pink halo round sun; iridescent clouds appeared; fine glow, and afterglow in the evening.

"March 9th, D.B., 71°; W.B., 58°; iridescent clouds of filmy character, halo very pink; splendid afterglow in evening; not very fine in the morning.

"March 10th, D.B., 75°; W.B., 61°; barometer falling, tem-

* In my original notes I described these clouds as Herschel's clouds but have here termed them iridescent clouds for the sake of uniformity.—W.A.J.

perature falling; splendid pre-glow, and glow in morning; peculiar streaky clouds coming up. Iridescent clouds at noon. Remarkable sun appearances at sunset—(see description in report of the Mathematical Society, Port Adelaide, 1885).

"April 17, D.B.,59°; W.B., 54°; max. temp., 65°; min. temp., 48°; m. bar., 30·46; very fine pre-glow and delicate change in colour of clouds, some being of transcendent beauty; filmy clouds formed, and became iridescent. Halo changed from pink to ice-halo. No glow in evening.

"April 22nd, D.B., 67°; W.B., 55°; max. temp., 75°; min., 52°; m. bar., 30·24; iridescent clouds; rather high clouds.

"April 30th, D.B., 66°; W.B., 52°; max. temp., 76°; min., 50°; m. bar., 30·32; cirrus clouds, rather heavy; beautifully iridescent at various times.

"May 1st (see account of notes further on)."

The dates on which these notes were taken show that the iridescent clouds are not specially connected with any new factor in meteorology, and that they are not connected with any particular kind of sky glows, unless, indeed, glows are connected with some peculiar form of water, and that the conditions required for glow appearances render the existence of iridescent clouds more or less possible.

The recorded observations of many persons are such that they must have mistaken portions of ordinary cloud halos for iridescent clouds, as the descriptions given in their cases are actual descriptions of halos in different positions, with the misnomer, "iridescent clouds."

There are various apparent changes in breadth of the limb of a cloud halo, as its distance from the horizon varies, that render it very possible for an inexperienced observer to fail in recognising a halo in every portion. It is important that future observers should discern the difference between the two classes of phenomena; and the two appended descriptions are therefore fully extracted from my meteorological notes.

Note 1st.—April 17, 1885. Readings are for the previous twenty-four hours—Dry bulb, 59°; W.B., 54°; max. temp., 65°; min. temp., 48°; mean bar., 30·46; barometer falling slowly; temperature rising. Most beautiful sunrise and pre-glow; very fine change of colour, first from the higher clouds, when cross polarization was evident. Then the lower clouds became illuminated in a beautiful manner with various tints, all tints ending in a yellow, after which clouds became white. The clouds, all of a delicate nature, became iridescent when near the sun about 10 a.m. The colours bore no reference to the angular distance from the sun within certain limits; thus the colours were not observed in the cloud patches, whose angular distance from the sun exceeded that of the limb of the pink

halo visible at the same time. This halo was beautifully clear and merged into an azure sky. The cloudlets, or cloud-patches, as they approached this pink space became variegated with most beautiful tints. In some cases these tints seemed to follow roughly the sinuosities of the clouds, pink being always at the edge. This pink was brighter than that of the halo into which it merged. The character of the clouds was that of cirrus, or cirro-cumulus. The structure was very delicate, resembling filaments of cotton wool in very loose heaps, with changing iridescent hues. As the clouds approached the sun they got brighter in colours, and as they got within about 6-8 degrees from the sun the edges nearest became tinted with the ordinary colours seen so frequently round the moon, and also round the sun when it is viewed by reflection from a surface of water contained in a vessel deep and black. The iridescent tints observed were pink, green, blue, orange, and mauve; pink being in all cases at the edges. As the clouds coming up, or forming, changed in character to that of cirro-stratus, the colour of the pink halo changed and had a colder tint, until it became overclouded with cirro-stratus. By this time there was no pink halo, but its limb had been gradually becoming more sharply defined and bright, so that by noon it had assumed the definite limb of an ice-cloud halo. As soon as the clouds had taken the character of cirro-stratus completely, the whole phenomena of iridescence ceased. In the evening there was no glow proper, but the clouds becoming a little thinner the halo assumed a pinkish hue. Cross-polarization was observable before sunset. There was a greenish twilight, though not so clear as it is when the clouds are lower and a low pressure area is approaching from the west.

The second note relates specially to the rare phenomenon of a double halo.

Note 2nd.—May 1st, 1885. D.B., 67°; W.B., 53°; max. temp., 75°; min. temp., 50°; m. bar., 30·26. Barometer falling slowly. Wind E.N.E. A bright sunrise; sky full of various tints from very high clouds. Character of clouds, cirrus and cirro-stratus, the colours of the clouds augmented by cross-polarization. At 8.30 a cloud halo was observable, being very perfect, and nearly circular to the sun. The colours, as seen in order from the sun, were red, orange, yellow, green, bluish; the angular distance from sun varied from 18° to 23°. There was a second halo at an angular distance of about 46°, not quite so central as the smaller one. The distance was measured. The colours were in same order as the first series. Both the rings existed until 10 a.m., when the outside one vanished, and the clouds became thicker. The inside halo of about 23° lasted all day, with varying degrees of

clearness. The field within it was notably darker than the surrounding portion, which was lighter even than the sky beyond. The limb of the halo became wider as the sun approached the horizon. Presently the underneath side blending, vanished, whilst the remaining portion could well be mistaken for an iridescent belt of cloud. This at last became quenched by the brilliant crimson clouds. No glow existed. Moonlight during evening displayed a similar halo.

It will be seen from the two descriptions just given that frequent mistakes might be made in taking a portion of some halo for iridescent clouds; and as the character of polarization is very obscure, it is almost impossible to distinguish the difference by the aid of the polariscope, and experience in the various forms the halo assumes becomes necessary.

In many instances short pieces of rainbow might pass for iridescent clouds, but they can be instantly detected if viewed through a nicol-prism, as they can be completely quenched with the nicol-prism in radial position.

*The following note is important, as bearing directly on this part of the subject:—A tinted sunrise; sky overcast, with clouds and patchy colours to north-east, but to the west there was a fine exhibition of tinted clouds. The fine high clouds were tinted pink, and their light was polarised in planes passing through the sun, the clouds, and myself. Near the east no change was produced when the nicol-prism was rotated. The colour of the clouds was pink, and very bright towards the west portions of sky, opposite to the sun, which had not yet risen above the horizon to my sight; and a phenomenon existed that might easily have been mistaken for an iridescent cloud. A band appeared, with red to the outside and green to the inside of the circle of which this band formed a part. The inside area of this circle was tinted red, and it was nearly as bright as the red of the portion of ring described. This ring was evidently part of a rainbow, for the nicol-prism completely extinguished it when the long diagonal was at right angles to its circumference. But what was more important was the fact that the red within this ring, and also the red without—though there was not much outside—suffered extinction with the nicol in same position. It occurred to me that if the nicol were directed to the different points of sky corresponding to the position of the unseen rainbow, the light of the red haze would be extinguished with the diagonal of the crystal at right angles to the tangent. Trying this, I found it to be the case.

This is an important note, because of the character of polari-

* This note was inserted after the paper was delivered.

zation discovered. The note was taken at Gawler, and I found that at the very time this appearance took place the plains to the west were receiving a heavy rain.

It follows from this that there are several forms of apparent iridescence: the halo forms, rainbow fragments, and the true iridescent clouds; and it is necessary to distinguish between them if we wish to learn much respecting the true iridescent clouds.

The limits of position of such clouds are, in reference to the sun, evident from the notes. Thus they are seen furthest from the sun both at sunrise and sunset, and closest at noon. They are always within the limits of the pink halo, and this is noticeable in connection with the remarkable change in the dimensions of the pink halo from day to day, and from morning to evening, the pink halo being more extended at morning and evening.

When there are two layers of clouds the iridescence does not appear whilst the sun has a great altitude and whilst the one layer of clouds is between the sun and that layer from which the iridescence comes. But on these occasions the iridescence appears when the sun is lower; and then, when the clouds that can become iridescent are illumined at the proper angle, the upper clouds are in such a position that their most illumined portion is not in a line drawn from the eye through the iridescent clouds. At these times the iridescent clouds are most noticeable, owing to the amount of light and the darker background.

The statements here made are corroborated by other observers—Prof. A. S. Herschel, of Newcastle-on-Tyne. T. W. Backhouse, writing of his observations, says:—"Iridescent clouds have been seen at all times of the day, but they have been most strikingly noticeable near sunrise and sunset. Colours don't appear when the clouds are far from the sun, they being then only white during day. * * * * At about half an hour to sunset iridescent clouds have been seen."

J. Graves refers to colours in the clouds like rainbow tints, but not regular, and having considerable altitude, at 26 minutes after sunset.

The reports from Christiania Observatory refer to the great distance of the clouds from the sun at sunset.

These notes show that in all places where iridescent clouds have been noticed they can be best seen when the sun is below the horizon, or when it is somewhat high in the heavens, the iridescence rarely appearing when the sun is just above the horizon. Their relation to particular cloud forms is indicated in many of the preceding notes. Thus they generally seem to precede clouds that come up and take the filmy form, from

which the ice halos appear to originate, as my notes show more conclusively than any other notes do. The relation of iridescence to similar clouds in other places than South Australia is shown by the following reports:—

Piazzi Smyth, writing from Edinburgh, says of the brilliant iridescent clouds of December 11, 1884—"Part of the time the iridescent clouds were eclipsed by a heavy cumulo-strata cloud, which showed clearly that the iridescent clouds were cirrus clouds, not as high though as the cirro-stratus haze, acting as a background to show off the beauties of the blue and green iridescent clouds."

The report from Christiania Observatory, already quoted.

The continuation of T. W. Backhouse's remarks. He says:—"The colours appear to be related to thin sheets of cloud-haze, which is white, and not coloured at a great distance from the sun." He describes the iridescence as being on a dense pallium of cirrus clouds. There are other reports supporting these, but it is needless to quote further.

The relation of iridescent clouds to states of weather is also indicated by notes that I have been able to make, and by reports of others. Their appearance is most prominent in all places during the cool months and on those occasions when fine ice-clouds are likely to be forming, or when they have been just disappearing. In Christiania they have been usually observed when mild and dry weather set in after frost. Corroboratory notes come from Prof. A. S. Herschel, T. W. Backhouse, and Piazzi Smyth. Miche Smith, of Madras, states that the appearance of iridescent clouds there is usually noticed before the approach of the monsoons, and these clouds are looked upon as a sure sign of monsoons being near at hand. These periods are the cool periods.

In reference to the spectrum and absorptions, it is sufficient to say that on all occasions the absorption lines have been indicative of dry atmosphere when the sky near the sun has been examined, the blue end of spectrum being relatively brighter, as it generally is when the air is somewhat dry and cold. The tints of the sky are numerous, and each tint has its own particular spectrum, so that a complete account of the tints in the various parts would require a special paper. The only point of value is that the air seems somewhat dry, and that the blue end of the spectrum is relatively brighter, indicating a cold upper stratum. This note only applying to my observations in South Australia.

Methods of observation:—I have tried many ways of observing these clouds. They can be viewed by reflection from substances that absorb part of the light. Thus water contained in a black vessel; surface of black glass; coloured solutions.

Water is best where practicable. It should be contained in a deep vessel, so that most of the water is in a deep shade. The colours can be seen very well in this way. In many cases it is preferable to use dark glasses of a neutral tint, as they can be used anywhere. The best way to use them is to stand in the shadow of some building so as just to hide the sun. Then with the aid of dark glasses the brilliancy of the sky is sufficiently reduced to enable the observer to distinguish the colours clearly. A very valuable method consists in the use of nicol-prisms and selenite film, thus obtaining any desired tint as background, and allowing one tint at a time to appear from the clouds.

Past Climatic Changes, with Special Reference to the Occurrence of a Glacial Epoch in Australia.

By Gavin Scoular, Corr. Mem.

[Read July 7, August 4.]

[abridged.]

Introduction.—Of the many complex problems with which the South Australian geologist and scientist have to deal none probably are more shrouded in the hidden mysteries of nature than those to which the above heading refers. That the formation known as the "drift deposits," constituting the Adelaide plain and other places, was a consequence of those climatic changes which were embraced by the period of the last glaciation of the southern hemisphere, I think geologists who have thoroughly studied these beds are fully agreed; but whether they, especially those comprised along the western seaboard of the colony, were laid down whilst the Australian Continent stood at a much greater elevation than now, or whilst in a more depressed state than it now is, is a subject worthy of careful investigation.

Traces of a Glacial Epoch in South Australia.—Instances of supposed ice markings, arising from the effects of actual glacial action or otherwise in connection with the Adelaide chain and adjacent seaboard, have been observed and noted from time to time by various geologists. Mr. Selwyn ("Geological Notes of a Journey in South Australia," p. 4) directs attention to a point in the valley of the Inman where he says:—"I observed a smooth striated and grooved rock surface presenting every indication of glacial action. The bank of the creek showed a section of clay and coarse gravel, or drift composed of fragments of all sizes irregularly imbedded in the clay. The direction of the grooves and scratches is east and west in parallel lines, or nearly at right angles to the strike of the rocks, and though they follow the course of the stream, I do not think that they could have been produced by the action of water forcing pebbles and boulders detached from the drift along the bed of the stream." Mr. Selwyn likewise notifies that this was the only instance of the kind he had seen in Australia, and though somewhat struck with the similarity of the markings to those he had formerly seen as ice markings in the mountain valleys of North Wales, he seemed, nevertheless, to retain a doubt in

his mind as to whether or not the scratchings he had seen impressed upon the rocks in the bed of the Inman had not at some former period been effected by the agency of running water. This latter hypothesis I am inclined to consider the most probable. As to the whole subject of these supposed ice markings I will endeavour to treat of more in detail subsequently.

The Rev. J. E. T. Woods ("Geological Observations in South Australia," first edition, p. 20), in treating of the geology of the Adelaide chain, says:—"In examining portions of it I have been led to think that probably they were of much greater height at one time. Indeed, it seemed to me, so far as a cursory examination could guide me, that there were very distinct marks of snow and the action of glaciers. This would declare the range to have been once of extraordinary elevation, probably the axis of some former continent."

Professor Tate, in his annual address to the Adelaide Philosophical Society, 1878-9, while treating of traces he had observed of former ice action in South Australia, (1) instances the grooves and scratchings observed by Mr. Selwyn in the bed of the Inman. "Smooth, grooved, and striated rock surface and moraine *debris* at Black Point, forming the southern boundary of Holdfast Bay." (3) "South of Field River, moraine *debris* and masses of transported rocks strewn over the top of the cliffs." (4) "*Roches moutonnées* surfaces of the mica slate on the south flank of Kaiserstuhl, and similarly large rounded surfaces at Crafers; both localities in the Adelaide chain." (5) Also an ice-worn pebble from the River Torrens drift, obtained by the late Sir R. D. Hanson. (6) And likewise near the gorge of the Torrens River there is a stream of *debris* extending along the side of the hill, which the Rev. J. E. T. Woods considers to be the remnant of a former moraine, and in the bed of the river a block of rock is situated, the sides of which are indented with striæ similar to that imprinted by ice action. "Such," the Professor adds, "are the signs of the former existence of ice action in South Australia;" and propounds the following theories as to how this excessive cold might have arisen:—(1) "The prevalence of a very much colder climate;" or (2) "that the land stood at a much greater altitude (say 10,000 feet), or the mountains may have had a more plateau-like form, and therefore need not have been so high, and consequently collected more snow;" or (3) "A combination of both." By these remarks the reader would scarcely know what opinion the Professor holds; but if he turn to the following page of the address he will, I think, be convinced that then, at least, the Professor was of opinion that the elevation of the Australian continent, and that only, had been the primary cause which led to the appearance of glaciers upon

the shores of Australia. I am given to understand that since the publication of his geological work on South Australia the Rev. J. E. T. Woods has seen fit to change his mind about the occurrence of a glacial epoch in Australia, and concludes that under the circumstances, and the present acceptation of the term, that it was impossible for a glacial epoch to have occurred in these regions. Returning, however, more particularly to the supposed ice striæ at Black Point, and assuming that the striæ on the surface of the stone there were effected by the passage of land ice, these seemingly ice-striated scores on its surface are impressed upon it in the direction of south and north, and *vice versa*. Guided by this fact, and presuming that the strata upon which the striated block reclines was at the time when the markings upon its surface were effected raised to an elevation of something approaching from 12,000 to 15,000 feet above its present altitude (an elevation of 10,000 feet is not sufficiently great to maintain glaciation either now or during the period of the drift in the neighbourhood of Holdfast Bay). If such had been the case, it is perfectly obvious that the area now occupied by St. Vincent's Gulf must have then been wholly filled with land ice. Therefore the glacier, if it was one, that left its supposed ice impressions upon the stone at Black Point was not by any means pursuing its most direct course to the sea; for according to the direction of the impressions left upon the stone, the glacier's path must have been either north, which is directly inland, or south, which was not at all likely, because in that case the glacier would have had to contend against and surmount the source from which it originated. Whatever may have been the primary origin of these striations, in a great measure at least they must now be confined to the realms of conjecture; yet, after fully considering the whole circumstances in connection therewith, I am led to believe that the furrowings in question were not produced by the action of land-ice. The phenomena, in all likelihood, might otherwise be referable to the original chemical inequalities in the character of the stone itself, the softer parts, after its exposure to atmospheric influences, yielding in a somewhat greater degree to the action of the north winds, and surcharged as these winds most frequently are with silicious sand, the furrowed markings upon the stone, and the path of these winds being in direct parallelism, suggests a hypothesis that the markings may have arisen in the manner described.

Then as to the fact that erratic boulders have been found sparingly strewn over the land surface in the locality of Black Point, and, also, a few, on rare occasions, have been discovered in other parts of the colony, chiefly near the present coast-

line. In connection with this subject it might be well to consider that during the peroid of extreme glaciation of the southern hemisphere, the permanent frost-line would stand from eight to nine degrees nearer our shores than it does at present, which would facilitate the passage of icebergs northward to a similar degree as the permanent frost-line extended in that direction. At the same time the eccentricity of the earth's orbit was at a high value, according to Dr. Croll's theory, and cold greatly predominating in the southern hemisphere, whilst the southern shore-line of South Australia we may suppose as submerged to the extent of from 800 to 1,000 feet. Judging from the dimensions of icebergs, noted by navigators in the Southern Ocean at present, the southern shore-line of Australia would then just be about the depth at which bergs of such dimensions might be expected to strand. The watery parts of which they were composed would soon give way to the action of the surrounding warmth, which would be considerably above the freezing point; consequently, the more coherent materials of these stranded bergs would soon drop to the bottom of the sea, and as the land rose the greater portion of this transported *debris* would emerge with it, as a puzzle for the future geologist to determine its origin. It is not at all improbable but that some, at least, of the boulders transported n this manner may have been striated by the action of ice on lands far away, long ere they started on their journey to be exposed afterwards on a distant Australian shore-line.

In his geological work on South Australia the Rev. J. E. T. Woods, (since the date in question I believe the rev. gentleman has altered his mind on the subject of Australian glaciation)—attributes the primary cause of the glacier action he had observed in the Mount Lofty Range to the great altitude of the chain during the glacial epoch. If any extraordinary elevation of the chain ever existed, it must have been long anterior to the date of the glacial epoch to which the rev. gentleman refers. The pre-Silurian rocks, constituting the Adelaide chain, since their deposition have been subjected to vast contortions and denudations; nevertheless, I can discover no evidence to show that the chain ever attained a much greater altitude above sea level than it now attains. It seems to me a much more probable hypothesis that the axial elevation of the range was first determined by some slight undulation of the beds, and for ought we know might have arisen in the ancient sea-bed, which by a succession of upheavals ultimately would become dry land. Denudation then would begin to operate, and the slowly-rising land soon afterwards would become furrowed into inequalities, and as the slopes of the first undulations enlarged, the primary sketch of a mountain chain, with rivers, gullies, and gorges, would be developed.

The relation and position which the younger South Australian rocks occupy upon the upturned edges of the old pre-Silurian beds are against the supposition of any very decided change of sea level since the deposition of the former. It will be recognised that no decided movement, either by way of depression or elevation, can have taken place throughout the area of the Mount Lofty pre-Silurian rocks since the deposition of the Yorke's Peninsula lower Silurian beds. These rocks, as exhibited there, are resting almost in a horizontal position upon the upturned edges of the pre-Silurian beds. The seemingly massive character of the beds and the manner of vertical fracturing, indicate to my mind at least that no general movements have occurred, either elevative or depressive, throughout the locality since their deposition. The same considerations are applicable as regards the horizontal condition in which the Miocene beds of South Australia are invariably found resting. Therefore, judging by the undisturbed condition of both the earlier and the later formations, leads me to infer that no upheaval has taken place in the neighbourhood of Adelaide sufficiently important to produce general glaciation of the surrounding country since before the deposition of the lower Silurian beds of Yorke's Peninsula.

According to Dr. A. Geikie, the line of perpetual snow in the Himalaya mountains is 19,000 feet above sea level. These mounbeing situated in latitude 22 degs. north, in round numbers, let us say Adelaide is situated in latitude 35 degs. south, by the same ratio Adelaide would require to be raised to the elevation of 12,000 feet above sea level in order to bring it within the influence of the permanent frost-line. Presuming Mount Lofty to have stood at about the same height above the Adelaide plain at which it now stands, in that case the mount would require to have stood at an elevation of nearly 11,000 feet above the plain to have brought it within the influence of perpetual frost, which height would barely meet the requirements of the theory propounded by Rev. J. E. T. Woods; and much less would it have maintained glaciers at the present coast-line. An elevation of quite 2,000 feet more would be required to have brought these parts within the influence of perpetual frost; for, as already stated, Professor Tate and others have detected signs of former glacial action in the vicinity of our present coast-line. Besides, had any portion of Australia been elevated to the extent of 12,294 feet about 150,000 years ago it could not have been of local application; it must have extended pretty generally over the entire southern portions of the continent of Australia. Had it been otherwise the drainage of the present river systems would have been completely altered by such movements, but which, from evidence

obtainable we have every reason to infer has not transpired, at least since before Miocene times.

Evidences of Submergence during the Last Period of High Eccentricity.—Having already pointed out the great improbability that the southern shores of South Australia were invaded with land-ice during the last glacial epoch, I will now endeavour to note a few of the evidences I have collected showing that the seaboard of this part of Australia at least was submerged when extreme cold last prevailed in the southern hemisphere to an extent of over 800 feet.

I am fully convinced that our so-called drift formations, extending at least to an altitude of 800 feet above present sea level, are chiefly of marine origin, and were deposited during the period whilst the last high state of eccentricity prevailed, and whilst the southern hemisphere was passing through its long secular winters of the period. In support of this hypothesis I may state that in well exposed sections of the deposits I have noticed the general characteristics which lead me to infer that the calcareo-argillaceous beds were deposited in comparatively deep and still waters, and which could not possibly have been the debris derived from the meltings of land-ice.

Where the streams from the hills have cut channels through the deposits so that the base of the formation is exposed to view, boulders and pebbles occur, presenting evidence of their having been beach worn. Such water-worn boulders and pebbles I have especially noticed occupying the base of the deposits in the gorge of Smith's Creek and in other gullies where the base of the formation is fully exposed throughout Munno Para East; also from the debris of a well evidently penetrating the basement beds of the deposits. On the western side of the Hummock Range boulders and pebbles of a most decided shore-line aspect have been seen by me also.

At considerable distances from the adjoining hills, imbedded in these calcareo-argillaceous deposits, specimens of drift-wood have not unfrequently been found, belonging to the same species still inhabiting the surrounding heights, which also militates against the theory of the actual glaciation of South Australia during the deposition of the drift deposits. For, as well known to botanists, none of the species of our gum tribe are adapted to withstand the rigours of severe cold, and I am of opinion also that few or none of the species of the land fauna would have withstood the severe change perpetual frost entails. The "Transactions of the Royal Society of South Australia," 1880, pages 27-28, states that nearly every species of our existing fauna lived during the period referred to. As to the appearance and extension of the *Diprotodon australis*

and similar congeners during the period, permit me to remark, it was not the actual ice-clad condition of the land surface, but a greater annual rainfall which Australia enjoyed that ushered in these creatures upon the scene. A greater rainfall implies that a more exuberant vegetation than we now possess was spread over the landscape, and following the laws of evolution, a race of animals in every way more powerfully developed is evolved to utilise it.

Inter-glacial, or Pluvial periods—probable date of and duration.—It is now admitted by geologists and scientists generally that the last glacial epoch was periodically interspersed by warm intervening periods of heat. There is indubitable proof from the interbedded character of the seaboard deposits, that during the period of the last glaciation of the southern hemisphere vast climatic changes occurred. As a sample of the many evidences which might be here cited in favour of that view, I will only instance a few which have come more prominently before my notice.

Near Penfield, in the Hundred of Munno Para, section 3,170, a stratum of gravelly material was discovered at a depth below the present surface of from eight to ten feet, interbedded in the calcareo-argillaceous deposits of the Gawler Plains. The locality in which these gravels occur evidently show that they were laid there whilst Australia was enjoying a much greater annual rainfall than prevails at present; and, also, that the sea level was considerably higher than it now is. Likewise, in the same hundred, section 3,160, about 24 or 25 years ago a bed of gravel was struck in an effort made to obtain water, about 20 feet below the present surface, which was also proven to be overlaid and underlaid by the usual calcareo-argillaceous deposits of the plain. Gravels and highly water-worn boulders are also to be seen exposed in the gorge cut by the waters of Smith's Creek in sections 4,158 and 4,161. In this section at least two beds of gravel are exposed to view, the uppermost being again overlaid with from 12 to 20 feet of calcareo-argillaceous material. In section 3,178, Hundred of Munno Para, about eleven or twelve years ago, whilst excavating a water-tank, after penetrating the calcareo-argillaceous subsoil characteristic of the plain, at a depth of about six feet below the surface a bed of gravel from three to four feet in thickness was struck, at the base of which indubitable evidence was shown that a fire not only had been lit there, but that it had been kept in an active state of ignition for a considerable period of time from the large quantity of ashes still remaining within the enclosure of a few stones collected together to constitute the primitive fireplace. Here evidence is forthcoming referring to two branches of physical science. (1) The pre-

sence of the gravel bed resting between the calcareo-argillaceous deposits supports the idea that the Gawler Plains not only enjoyed a much moister climate than they now do; and, also, that their relation to the sea level at the period must have been very different from what it was either before or after the event. (2) The excavation also proves that the aborigines of Australia had at that period entered upon the scene; and at that early date of their occupancy they had become sufficiently knowing to erect a rude circle of stones around the fire so as to retain the heat.

As further proof of the interstratified condition of the formation in Gawler West, whilst the late Mr. T. Munroe was engaged in the excavation of a large tank for the purpose of storing rain-water, after passing through from eight to nine feet of the semi-clayey deposits characteristic of the subsoils of Gawler Plains, a bed of gravel was struck, which impressed me forcibly at the time of its having been caused by river action, and, if so, it is evident that the channel of the South Para—a little to the west of its outlet from the hills—then flowed over the plain rather more than 200 yards to the south of its present course; and that its channel was then about 30 feet higher than the level of the bed of the present stream. Similar illustrations may be found in sections given in various papers published by the Royal Society of this colony.

Probable Date of the Last Glacial Epoch.—At the time when I penned my brief sketch of the "Geology of Munno Para" I was under the impression that the last extreme glaciation of the southern hemisphere in point of time had preceded the epoch in the northern hemisphere known as the glacial, and its intensity had begun either about 980,000 years since or about 720,000 years ago. But after reconsidering the subject more carefully I arrived at the conclusion that it must have been in connection with the last term of high eccentricity that a glaciation of the southern hemisphere occurred, which, according to Dr. Croll, took place between 240,000 and 80,000 years ago. At that period a high state of eccentricity continued for a term of 160,000 years, which according to the laws governing the precession of the equinoxes, each hemisphere would pass through during that term about eight periods of extremes in cold and heat. The diversiform character of the summers and winters which then must have prevailed would lead to a much greater rainfall than is now witnessed over the Australian continent, and which would continue in a state of greater or lesser intensity for about 10,000 years respectively.

A Glacial Epoch at the Close of the Miocene Period.—Scanty but indubitable relics are left to show that the continent of Australia was affected by cosmical changes

at the close of the Miocene epoch, in a similar way to that which took place at or near the close of the Pliocene period. Though the evidence be somewhat defective, I will here state that the beds known as the "Upland Miocenes" are partly of marine origin, and partly fluviatile and æolian. Therefore whilst the beds were being added to the series by the influence of the two last-named conditions, a vast difference in the temperature of the Australian climate must have prevailed from what we now witness. In the indubitable marine beds at Aldinga Bay and the Murray Cliffs, the more delicate, or what we might term the more tropical species of the fauna, gradually disappear throughout the lower beds of the formation, until at either place the uppermost fossiliferous bed in the series is entirely restricted in its fossil remains to a species of oyster, and that, too, I am credibly informed, is not at present an inhabitant of South Australian waters. Thus a study of the marine beds in question teaches—Firstly, that as the cold was gradually setting in, the molluscan species which are most indigenous to tropical waters disappeared from our shores. At last even the oyster, which is considered to possess a wider geographical range than many other of the molluscan genera, succumbed to the rigours of the increasing cold also. At both localities the bed is overlaid by one known as the non-fossiliferous Miocene clays. These non-fossiliferous clays arose from the azoic character of the waters of the surrounding seas of the period; and that the deposits of a sandy nature, found sparingly distributed throughout the bed, are the æolian accumulations of the period there can be little doubt. As the deposits ascend in height above present sea level the æolian constituents become more prominent in character, until they reach an altitude of about 1,100 feet, when they become, so to speak, the equivalents in time of the calcareo-argillaceous beds of the Adelaide, Gawler, and other seaboard plains.

I have been led to conclude that the whole deposit, in part sub-marine and in part sub-aerial, was formed whilst our earth was passing through one of its periods of high eccentricity, and consequently this change for the time being of the earth's pathway round the sun would naturally lead, in certain latitudes at given periods, to an excessive amount of rainfall, and at others excessive drought; and such extremes of secular change would also lead to a corresponding amount of geological disintegration, and it was during such a period, as it seems to me, that the non-fossiliferous Miocene beds in the neighbourhood of Adelaide and other kindred Australian deposits were developed.

Why the Seaboard Drifts of South Australia are Void of Marine Fossil Remains.—Profound depths and varying tempera-

ture of the sea, as is well known, as effectually barricades the free passage of many of the higher orders of marine life from the shore-line of a continent or island, in which they are not native, as high altitudes constitute a line of demarcation to the terrestrial fauna inhabiting two separated plains of a great continent. In this way it is quite possible under favourable conditions that change of temperature alone may depauperate marine life, or may even give an azoic appearance to deposits which are of marine origin. The evidences which have led me to these conclusions — that the South Australian seaboard recent accumulations belong to that class of deposits—are summarily stated in the following sentences :—

Mr. A. Wallace states ("Distribution of Animals;" vol. I., page 447) :—"Between the Fiji Islands, New Caledonia, the Solomon Islands, and Australia, the depth is about 1,300 fathoms, and between Sydney and New Zealand 2,600 fathoms, showing in every case a general accordance between the depth of the sea and the approximation of the several faunas." By referring to a map of the world showing the undulations of the ocean bed, it will be seen that the continent of Australia is surrounded on the south and west sides by a depth of water which at no point is less than 15,000 feet. The sea depth between New Zealand and the islands to the north as well as between New Zealand and the continent of Australia, up to the 25th degree of south latitude, is not less than 15,000 feet, whilst the depth between New Zealand and Sydney is 600 feet more. According to the facts relating to the distribution of life in abyssal depths, as supplied by the Challenger reports, we might infer that little or no direct intercourse can take place at present between the molluscan fauna dwelling in the shallower waters around New Zealand, or her satellites, and the south and east shores of Australia. Also, if we examine the physical and palæontological aspects of these countries, we are led to believe that these conditions not only at present exist, but that a similar state of sea depth prevailed between those countries throughout a vast period of past geological time. Consequently when extreme glaciation pervades the southern hemisphere, a barrier is not only thus set up against the direct passage of the molluscan fauna that inhabit the shores of New Zealand and the islands connected therewith, and the more temperate shores of southern Australia, but it also prevents the free intercourse of the oceanic fauna (if there be any) that inhabit the shores of Victoria and those of New Zealand.

Depending upon the consideration that no very great difference has arisen in the relationship of sea and land within the Australian area since the period of the last great glacia-

tion, I am led to conclude that, as the insetting cold advanced towards the equator, the semi-tropical fauna then inhabiting the South Australian area would migrate or creep northward, as their natural habitat receded in that direction; and from the profundity of sea-depths which separate adjacent lands from the southern shores of Australia, the South Australian shores would remain depopulated of the higher orders of mollusca so long as this state of cold prevailed. As the cold reached its severest point the sea increased upon the land in the latitude of Adelaide to the extent of from 800 feet to 1,000 feet, and the deposits laid down in that azoic sea when elevated into dry land would assuredly be void of most if not all indications of marine life.

That a somewhat similar phenomenon occurred during middle Tertiary times might have been noted, and that one or more of the species common in the Miocene beds of South Australia migrated northwards at the close of that period and are now found inhabitants of the tropical seas.

It would appear that a somewhat similar theory arose in the mind of Mr. Selwyn to the one I have advanced. He states at page 25 of his "Physical Geology and Geography of the Colony of Victoria":—"The absence of any evidence of marine life may probably be fully accounted for by the character of the deposits, which indicate physical conditions that must have been highly unfavourable to the development of animal life in the area." According to this quotation it seems that the same non-fossiliferous conditions extend throughout the recent deposits of Victoria as prevails in South Australia. Being assured then that so great a similarity prevails *palæontologically* throughout the recent deposits over so widespread a tract of the Australian continent, suggests that these effects were produced by some equally widespread a cause.

By reference to a map of the world we observe that no analogy exists in the distribution of sea and land in the northern and southern hemispheres. In every case the continents that are situated within the former enjoy a diversity of temperature such as that hemisphere sustains; consequently the inhabitants of these lands and the adjoining seas have free access to accommodate themselves to that degree of temperature best adapted to their wants. If the cold of the frigid zone for a time be extended equatorwise, the inhabitants, both of land and sea, of these regions have natural facilities afforded to shift their area of occupancy; or if the heat for the time being of the torrid zone incline towards the north the abode of the inhabitants of these regions is similarly extended. In short, throughout the northern hemisphere, at whatever parallel of north latitude the permanent frost-line may be

situated, the littoral, or shore-line inhabitants of the adjoining seas have free access to migrate from north to south, and *vice versa*, in such a manner as to follow the isothermal conditions of their wonted habitat.

Such accommodations, however, are not applicable in every case with regard to the inhabitants of the continents situated in the southern hemisphere. It is true the marine fauna bordering the shores of Southern Africa, America, and Australia have in each case free access to migrate northwards in the event of the isothermal conditions in the southern parts of these continents getting colder. But so far as Africa and Australia are concerned, at least, considering the great expanse and ocean depths that are situated to the south of these countries, it is questionable if the existing fauna were driven northwards by an increase of cold, whether the breaches thus caused in the ranks of animal life in these regions would be immediately replenished by others indigenous to a colder habitat. With regard to Australia, New Zealand might be looked upon as being a sort of halting place in the passage of marine life passing between the frigid waters of the antarctic circle and those of a more temperate character which encircle the southern shores of Australia. But if the depth of sea be considered which lies between the shores of Victoria and New Zealand, it becomes almost an impossibility that such a highway could have been available for the migration of animal life during the time of the last extreme glaciation. The resembling character existing between the non-fossiliferous clayey Miocene beds, also the upland Miocenes, and the more recent deposits constituting our seaboard plains, forcibly show that all were originated in a similar manner.

Since the foregoing was written I have revisited the grooved and striated rock surface at Black Point, Holdfast Bay, and from what I then saw and could determine, the views as stated in this paper regarding the phenomena were fully substantiated. On the top of the sea-cliff, where the surface of the bed-rock has been exposed to the action of the north winds and that of the sea for centuries, the grooved and striated rock-surface rest, and consists of a bed of hard, slightly micaceous, schistoze rock, occupying very nearly the anticlinal apex of one of those minor folds of so frequent occurrence throughout the pre-Silurian rocks of South Australia. The strike of the bed upon which these interesting striations are impressed is in a parallel direction with the furrowings, which are south-south-west by north-north-east, and dip at an inclination of from six to eight degrees to the west. Another peculiarity I observed on revisiting the scene of these striations (which, to my mind, have

a tale to tell against their being of glacial origin) is that the striæ on the rock-surface in no case are prolonged below the recent deposits, unless where they are of sub-aerial origin. Such proofs strongly lead me to believe that the striæ in question are not of ice origin, but were effected by other agencies at a period subsequent to that of the last great ice age.

As a further corroboration of the opinion that these striæ on the rock-surface at Black Point are not of glacial origin, on revisiting the locality I discovered about fifty yards north-easterly, in the bed of a small stream, similar markings to those observed at Black Point, showing evident signs of their having been effected by atmospheric and aqueous agencies; with this marked difference, however, that they were impressed upon the rock-surface in the direction of nearly east and west. This fact still further convinces me of the opinion that some of the beds in that neighbourhood are not composed of equally destructible materials, so as to withstand the wear of time in a uniform degree. The markings on the top of the sea-cliffs, to my mind, are referable to atmospheric and æolian agencies, whilst those of the watercourse have been caused by the combined action of the atmosphere and the little streamlet.

Post-Miocene Climate in South Australia

(Being in part a rejoinder to Mr. Scoular's Paper).

By Professor Ralph Tate, F.G.S., F.L.S., &c.

[Read August 4, 1885.]

I have never advocated with any earnestness that climatic changes of high value are due to geological rather than cosmical causes; and in a course of public lectures, delivered last year at the University, I applied Dr. Croll's hypothesis to the elucidation of certain physiographic peculiarities of Central Australia, which are co-ordinate with the glacial signs in the southern part of the province. I have had long in preparation a paper on "Climate past and present in its relation to the distribution of animal and vegetable life in Australia," an outline of which formed the basis of the lectures above referred to; but the wish to know by actual observation the physical features of the basin of Lake Eyre has stayed my pen. It is, therefore, with much reluctance that I am forced into this controversy before I am prepared to encompass the questions involved in all their manifold bearings.

Ice-marks.—These and other signs of moving ice are now known in South Australia, at altitudes from 50 to about 2,000 feet from sea level. They have been examined by several geologists well versed in reading such signs in Canada, Great Britain, and Central Europe, who have without exception unhesitatingly attributed them to the action of ice. In Victoria similar phenomena have been observed by Griffiths and Stirling. In the face of the facts, thus daily accumulating, they must be daring men to dispute that *Southern Australia has had a climate sufficiently cold to originate glaciers at comparatively low elevations.* The strenuous opponents to such generalization are Professor Hutton, of New Zealand; Dr. Lendenfeld, of Sydney; and Mr. Scoular, our corresponding member.

Prof. Hutton inclines to the opinion that the glacial period in Australia could not have been so severe as is demanded by the altitudinal and geographic range of the ice-marks observed in South Australia and Victoria, else the simultaneous glacial period in New Zealand would have been of polar severity, which he thinks it was not because of the great abundance of animal life at that time. He writes*—"Neither are there any signs of a Pleistocene glaciation of New Zealand greater than at present."

* Quart. Journ. Geol. Soc., vol. xli., p. 213, 1885.

Prof. Hutton does not make it clear to my comprehension that the Pleistocene deposits so rich in bird remains were coeval with the glaciation of the southern hemisphere. One circumstance which seems to very much invalidate Prof. Hutton's arguments is that New Zealand has been the scene of great oscillation of level during Tertiary times; "the Oligocene and Miocene systems attain an elevation of 4,000 feet in the North Island;" "the marine beds of the Pliocene system attain an elevation of more than 2,000 feet near Napier;" and in the Pleistocene period "I believe that the sea stood much higher than 800 feet in Canterbury," *op. cit.*

[*P.S.*—August 15. More recently Prof. Hutton has modified his opinion, as I gather from the following abstract of a paper read before the Lin. Soc. N.S.W., July 29, 1885:—"The author discusses the phenomena which have been adduced as evidence for the former existence of a glacial epoch in Australia, and shows that they are susceptible of a different interpretation. He distinguishes between a glacier epoch, such as has occurred in New Zealand, in which, owing to various local, but only local, causes, icefields prevailed over much larger districts than at present, and a glacial epoch, such as has been demonstrated in the northern hemisphere, which is the result, not of variations caused and limited by local circumstances, but of alterations universal or cosmical in character. The glacier epoch in New Zealand is regarded as anterior to the glacial epoch of the north."]

Dr. Lendenfeld* characterises my observations† as very vague, and Mr. Griffith's‡ evidence as of a still more vague character. Did I not know that Dr. Lendenfeld has had a large practical alpine experience, I should have been disposed to regard his statements as indicative of incompetency to appreciate at their proper value glacier signs irrespective of their position. It seems to me that his main objection to the acceptance of the observations of myself and others is that we began at the wrong end. He writes:—"Glacial traces must be looked for in the mountains first," and then when found "the investigation can be extended down to the low lands to ascertain how far the glaciers reached." Indeed, I cannot refrain from remarking upon the obvious under current of self-laudation running through his paper—as it were to say, I will ignore all these evidences as I wish to have credit for the discovery of glacial remains; of course up the mountains I will go. And he found them on the high plateau of Mount Kosciusco, but not below 5,800 feet, and concludes that "at the time of the

* Proc. Linn. Soc. N.S.W., vol. X., p. 2.
† Trans. Roy. Soc. S. Aust., vol. II., page lxv., 1879.
‡ Trans. Roy. Soc. Vict., 1882.

glaciation of the southern hemisphere the climate was then not very cold, so that the glaciers only covered the highest part of the Australian Alps, and it is not likely that glaciers existed anywhere else in Australia at the time." Doubtlessly in a certain sense we should look rather towards the high elevations for glacier signs, as there the glaciers would be the last to disappear; but as the lowland tracts may have longer preserved the scorings, scratchings, and other evidences of the passage of land ice by the protecting superficial coverings laid down over its retreating path, we may hope to be more successful in a search here than at the highest elevations where the process of weathering is so much more energetic and persistent. So far as regards the higher levels of the Mount Lofty Range, ice marks are not at all likely to have been preserved on the friable sandstones which everywhere crown elevations above 1,800 feet.

[*Postscript.*—Dr. Lendenfeld "draws attention to some further evidences of ice action in the Mount Lofty group, near Adelaide, where some glacier-polished rocks, with some very well preserved striæ have been discovered and photographed."—Abstract of Proc. Lin. Soc. N.S. Wales, July 29, 1885. In the absence of particulars I cannot be positive, but there is strong circumstantial evidence that this so-called discovery relates to the ice-worn surface at Black Point, Hallett's Cove, which was photographed by Mr. H. Y. L. Brown, Government Geologist, copies of which were sent by him to Sydney. Following upon the very severe strictures on the observations of self and others in reference to the presence of glacial signs, this admission of Dr. Lendenfeld—the prince of sceptics—must remove all doubts as to their value.]

Mr. Stirling* has recently announced the presence of ice-worn and scratched rocks and other glacial signs at elevations as low as 1,000 feet above sea level in the Omeo district, Victoria.

Mr. Scoular's antagonism is the most serious, because he has examined the glaciated surface at Black Point, which he attributes to the action of blown sand; but I will defer for awhile my criticism on that gentleman's observations and deductions that I may now deal with a phase of the inquiry of fundamental importance, namely:—

THE EXTINCTION OF THE ARID AREA IN AUSTRALIA DURING THE GLACIAL EPOCH.

It seems to me that the authors so strongly opposed to the glaciation of southern Australia take for granted that it never existed, and therefore reject the evidences as vague, or explain

* Roy. Soc. Victoria, July, 1885.

them away by the aid of other agents. Moreover they have proceeded on the assumption that the annual temperature at any one place was affected during cosmical changes in proportion to its distance from the advancing or retrograding wave of glacial cold; that the environments remained the same, and therefore by rule of proportion the increment or decrement of heat was invariable. Thus, then, the main grounds of rejection of the evidences of glaciation may be briefly stated as follows:—That the existence of glaciers is incompatible with the high temperature that must have prevailed over this area during the glacial epoch of the southern hemisphere.

If the east coast of the South Island of New Zealand were known only, with what incredulity would have been received the announcement that the transalpine glaciers reached to within 700 feet of sea-level, or 2,000 feet lower than those on the east slope. Of course we understand the why and the wherefore; but had we formed preconceived notions touching the climatology of the western region, based on eastern experiences, how erroneous would they have proved.

Existing causes tend to maintain a higher mean temperature for southern Australia than is demanded by its latitudinal position, and to these Dr. Lendenfeld appeals as fatal to the existence of glaciers except on the alpine plateaux, even at the period of extreme cold; and Professor Hutton argues much in the same way. But were these causes operating with the same intensity always as now? I think not; and their removal and the reciprocity of actions in consequence thereof may have resulted in the production of a climate which, compared with the present, may have offered as great a contrast as those of the eastern and western slopes of the New Zealand Alps.

To state my case:—If we study the present distribution of temperature and aqueous precipitation on this continent, we shall recognise a central arid area from which all around the rainfall increases—tropical rains to the north and winter rains to the south of it. Here in this almost rainless region originate those desiccating winds, which materially elevate the temperature of the southern shores. Guyot has shown that the existence of a dry belt on either side of the tropics is due to permanent laws governing the motion of aerial currents. The locus of high barometric pressure or descending equatorial air-column has a seasonal motion within certain limits—being dependent on the position of the sun in its annual path; so also will it be affected by changes in the obliquity of the earth's orbit. The area of high pressure, or of aridity, has an annual oscillation, and must have also a cyclical one. This

being so, and given the southern hemisphere its maximum of cold and the high latitudinal position of the sun in the northern hemisphere, it follows that the system of trade winds in the southern hemisphere is shifted further north, and with it those other effects which are correlative, bringing our southern shores into the region of copious summer rains, and Central Australia within that of winter rains. More than this, the dry belt would be shifted so far to the north as to be almost obliterated, or, at least, greatly narrowed by its proximity to oceanic waters.

Under such influences the climate of Southern Australia is changed in a way not hitherto foreseen, and the question, did perennial ice exist on its mountains? is not so difficult to answer. By induction we should have been led to anticipate the discovery of those glacier signs, the interpretation of which has created so much unnecessary controversy.

A glacial period and a pluvial period mean the same to me, being referrible to the same cause—rain or snow—according to latitude or elevation.

I have persistently argued for some years that the rainfall has greatly diminished since the Pliocene period, the evidences of which are more striking in Central Australia than in more southern latitudes because of the present poverty of rain there.

A vastly increased rainfall over what is now the arid region of Australia in former times is demanded by the extinct rivers and lakes and the former existence of large herbivores.

1. The Extinct Rivers.—All the watercourses which originate within the dry belt are characterised by the absence of water. It is only towards their sources that they collect the surface drainage, and then only at distant intervals of time. Many of them are of great width and are traceable for more than 100 miles to the depressed area around Lake Eyre, where they become obliterated many miles from the present shore. The Paroo and other of the north-western tributaries of the Darling no longer carry water in their lower sections. The volume of discharge from the River Murray must have been many times greater than now. (See my paper on the River Murray, p. 30, et. seq., vol. VII. of these Transactions).

2. Extinct Lakes.—Lake Eyre is the centre of the continental drainage, and is maintained at the present time by the flood-waters of the Cooper and Diamantina, which are supplied by tropical rains. But toward this extensive depression there are directed many dry river-beds, whilst hundreds of square miles around the present lake margin are covered with sandhills, separated by loamy interspaces, which are littoral sandbanks marking the successive stages in the contraction of the water

expanse. The basin of Lake Torrens exhibits the same peculiarities as that of Lake Eyre; the margin of the former lake is 111 feet above, whilst that of the other is 39 feet below sea level. The river courses of the Lake Torrens basin are short and rapid, the rainfall is a little more, and not unfrequently the creeks discharge their contents into the lake.

With the features of the Lake Torrens basin I am familiar, and will submit now the chief facts which induce me to the opinion that the present lake is but a remnant of its former self, and that the sandhills are of lacustrine origin.

The plain of Lake Torrens is at its margin chiefly composed of loams and gravels, shed from the adjacent slopes, or transported from the far distant Flinders Range by the torrential streams which debouch upon the plain; other constituents of the gravel are flints and agates quite foreign to the district. Here I picked up a pebble of obsidian. Further out on the plain these drifts are concealed by low, more or less parallel, sandhills separated from one another by loamy flats. The wide trumpet-shaped mouth of the valley of the Aroona River is occupied with breccia and conglomerate to 50 and 80 feet above the level of the present stream course.

The sandhills have a trend conformable with the edges of the main body of the drift, which is by estimate at least 100 feet above the level of the lake-waters. The sandhills are covered with vegetation, and are quite stable. The sand is coarse, sharp, and externally red coloured; angular fragments of white quartz and dark-coloured quartzite up to five millimetres diameter may be gathered at the bases of the sandhills. No fossils have been detected in the sandhills, but the loams have yielded remains of land vertebrates.

3. Extinct Fauna.—That the lake areas of Eyre, Torrens, and Frome were once inhabited by terrestrial and fluviatile animals now totally extinct or repelled is a well established fact; perhaps no other part of Australia has yielded such abundant remains of *Diprotodon* as that about Lake Eyre. Unfortunately the sequence of the beds yielding mammalian and other terrestrial remains is not known; but whether they be isochronous or not—tableland sandstones, the deeper-seated clays and gravels, the more superficial loams, or the sandhills—they all indicate a lacustrine origin. Mr. Debney† obtained fossils from the escarpment of a table-hill, between the Warburton and the Cooper, on the east side of Lake Eyre, in the midst of the sandhill country. They consist of the phalanges and other bones of an emu-like bird, crocodilian scutes and teeth, chelonian plates, and vertebræ of fish. Similar organic

† Trans. Roy. Soc. S. Aust., vol IV., p. 140; 1881.

debris were obtained in a well-sinking near Lake Hurd, north of Billeroo trig, in the basin of Lake Frome; they occurred in a stratum of sharp white sand underlying a clay which is reported to me to have embedded in it stems of "mulga" (*sic*). At Kalamurina Station, near Cowarie, on the Warburton river, about 50 miles north from the first-named locality, and in the same physiographic region, there has been exhumed the fore part of the skull of a crocodile, differing from *C. porosus*, inhabiting tropical Australia, by its shorter, broader, and more massive snout. The specimen graces the Museum at Port Adelaide.

In this connection may be reported the discovery of the lower jaw of *Macropus Titan* and mandibular teeth of *Ceratodus Forsteri* in the bed of a dry lake near Momba Station, about 25 miles north of Wilcannia. The fossils were gathered by Mr. W. Hogarth, and presented by him to Mr. Gavin Scoular, who has obligingly submitted them to me for determination. The former gentleman writes to the latter that the lake is, according to the statement of the Astronomer Royal of Sydney, 350 feet above sea level, and that at times of high floods is filled by the waters of the Darling river, but has not been so until the one of this year since 1864; that after the flood of 1864 cod and other fish were caught in the lake. The highly mineralised condition of the organic remains above referred to is suggestive of their having been washed out of a red loam or earth, and precludes the probability of their recent origin.

As I have elsewhere* pointed out, the existence of the gigantic herbivores in the "dry zone" demands climatic conditions favourable to the growth of a vegetation capable of supporting them, and that their extinction is attributable to those climatic changes which brought about dessication, involving a reduction in volume of the waters of the lakes, and finally converting their basins into saltpans.

I need hardly urge that the replacement of the arid plains by freshwater seas, though a consequence of an amelioration of climate, must have had a reciprocal effect, conversely as the existence of a dry zone produces aridity and thereby intensifies the effect.

Specific Criticisms on Mr. Scoular's Paper.

The Ice-marks at Black Point are on sheared surfaces across the bedding, and their direction is nearly parallel with the trend of the coast. But the consideration of the direction of the marks is of little moment, as we cannot restore the outline of the country at the period of their production for reasons hereafter to be stated.

* Trans. Roy. Soc. S. Aust., vol. II., p. lxvii., 1879; vol. VII., p. 32, 1884.

It is easy to attribute each isolated feature of glacial phenomena to some other cause; but will any other agent than glacier ice satisfy all of them, taken collectively?—the shearing of rocks, furrowed, scratched, and polished surfaces, and morainic debris.

Mr. Scoular has unwittingly succeeded in contradicting himself by attempting to prove too much. When having satisfied himself that the glaciated surface at Black Point is the result of the attrition of blown sand he appeals to similar markings "showing evident signs of having been affected by atmospheric and aqueous agency—the combined action of the atmosphere and the periodic waterflow."

Elevation of sea level and origin of Pliocene Drifts.—The application of Croll's hypothesis demands, according to the opinion of Mr. Scoular, the elevation of the sea level around our shores to 800 or 1,000 feet. This may be true, but if the land has not moved since then our drift-beds should be marine; yet, Mr. Scoular has failed to prove them to be so, whilst the palæontological evidences strongly favour the view of their subærial origin.*

I am unacquainted with marine Pliocene beds in South Australia, or even in Australia. We have nothing equivalent to the Wanganni system of New Zealand, therefore the marine equivalents to the Pliocene Drifts, if extant, are submarine. If, therefore, an elevation of the sea level to a height of about 1,000 feet took place during our glacial period, and as no cotemporaneous marine debris occurs, it is a necessary deduction that the land stood so much higher then than now, to escape the submergence.

Again, if the low level plains are of marine origin, why not the upland plains, which present the same characteristics? In the case of the Willochra plain, an elevation of sea level to a height of 1,500 feet is required for its marine origin; in the case of the Terowie plain, rather more; and in that of Yarcowie, close upon 2,000 feet. Here Mr. Scoular is very inconsistent, for, while inadvertently admitting the lacustrine origin of the high plains, he will not apply to them the same arguments which lead him to attribute a marine origin to the low-land plains. Surely if the vast area—more than three-fourths of the whole settled parts of South Australia—had been buried beneath the sea some vestiges of its marine fauna would have been forthcoming.

Further, a greater elevation of the land is demanded by the extension of the drift deposits below sea level. In the Adelaide bore the drift beds have a thickness of 69 feet, their base

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* Trans. Roy. Soc. S. Aust., vol. II., pp. lxii., et. seq.

being, however, 70 feet above sea level; but on the western side of the Older Tertiary escarpment at Adelaide the drift beds are at deeper levels and are projected below low-water mark in Holdfast Bay. In the Port Wakefield bore these beds were bottomed at 312 feet below sea level, and throughout their thickness are highly charged with carbonaceous muds. In the Stirling bore, near Port Augusta, the base was not reached at 460 feet, corresponding to a depth of 356 feet below low-water mark. Here, also, carbonaceous muds were passed through, and a few fragments of crocodilian scutes were obtained.

It has not been definitely proved that the deposition of the Pliocene Drifts was contemporaneous with the existence of our glaciers, but their mode of occurrence, nature, and organic remains imply great aqueous precipitation during the period of their accumulation, and therefore presumably coeval with the glacial phenomena. The view of the lacustrine origin of the drifts of the lowland and upland plains may seem at first difficult of acceptance, because of the necessity for barriers across their lower ends to impound the drainage. Actual barriers are recognisable in a few cases, as that formed by the Older Tertiary escarpment at Adelaide, through a gap in which the River Torrens now flows; a similar feature is seen in the valleys of the Light and Gilbert, near Hamley Bridge. In most of the upland plains the flanking hills converge at the lower end, leading one to suppose that at deeper levels they increasingly approach one another to form a gorge; but in most cases the great depths to which the old valleys have been filled precludes all hope of ever learning much on this point. As to the great lake region of Central Australia, the configuration of the present surface permits of a vast increase in the area and depth of the water in each basin. In the case of the Adelaide Plain, its lacustrine origin demands a barrier across what is now St. Vincent Gulf; but the truncated margin of the drift around its shores and the depth below sea level to which the drift extends at Port Wakefield, indicate that the gulf has been excavated out of the drift beds. From this and other circumstances it is not possible to restore the configuration of the land surface immediately prior to the glacial period, and therefore the pre-existence of barriers must remain an assumption, as also that the building up of terminal moraines may have been the primary cause of the filling up of deep valleys with subaerial detritus. Mr. Scoular argues against any Extensive Upheaval of the Land, because "the drainage of the present river system would have been completely altered." But the fact that the River Torrens has cut its way across the inclination of the strata in deep gorges and contrary to the

natural drainage of the country indicates that the formation of its bed took place prior to the development of the present configuration. The valley and gorge of the Lower Onkaparinga is another example of an old river system.

Existence of Gum-trees Incompatible with a Glacial Climate.—Mr. Scoular has referred the drift-wood found in the Pliocene beds to living gum-trees, but on what evidence he does not tell us, though doubtlessly true. But his statement that gum-trees do not grow at high altitudes is erroneous, as there are several subalpine species—*E. amygdalina* ranges to 5,000 feet on the Snowy Mountains, whilst shrubby states of other species locally known as "snow gums" ascend to the edge of the highest plateaux at 6,000 feet.

Marine Origin of the Upland Miocene.—Mr. Scoular does not adduce any proof of the marine origin of the gold-bearing drifts and coterminous deposits which range up to altitudes of 1,000 feet or thereabouts, and ignores the evidences furnished by their mechanical condition and the embedded vegetable debris. His facts touching the molluscan life of the youngest member of the marine Miocene deposits are very incomplete, and his deductions therefrom are very fallacious. It is true that oysters dominate the beds, but they had for associates several species of Pecten, some closely allied to the recent species *P. australis*, *P. bifrons*, and *P. pleuronectes;* the living *Placunanomia Ione*, and *Lucina dentata*, *Trigonia acuticosta*, a *Meleagrina* very near to *M. margaritifera*, *Cucullæa Corioensis*, a large *Donax*, and several other bivalves. Among gastropods *Cassis textilis* and *Haliotis nævosoides* are conspicuous; in other classes *Clypeaster Gippslandicus* (McCoy) and *Balanophyllia* sp. are noteworthy. If we may predicate climate from such an assemblage, it would not be in the direction of a colder climate than which now prevails over the same area. The apparent paucity of species in the oyster beds is probably due to destruction of their shells by the solvent waters freely admitted by these incoherent and superficial beds, as the majority of the fossils are those with calcitic tests.

Summary.

1. That the evidences of the glacier period in South Australia are numerous and pronounced, and reach as low as present sea level.

2. That the glacial phenomena were not local, but are attributable to those cosmic causes which produced glaciation at a more recent period in the northern hemisphere.

3. That the extension of the subaerial deposits of the glacial period below sea level demands elevation of the land at the period of their accumulation corresponding in amount at the

least with that of their present submergence. (Four hundred feet actually known.)

4. It is highly probable that upheaval was an important factor of climatic change at this period. The relationships of the Post-Miocene faunas and floras of the continent with those of the large adjacent insular masses demand a more intimate connection with the continental area than that which now obtains; this was probably furnished by elevation of the sea bed.

5. That the present arid zone of Central Australia was, during the glacial period, a region of copious rainfall, of fresh-water seas, and perennial rivers; now a barrier to the commingling of the south-western and eastern floras and faunas; it, at that time, was doubtlessly the line of migration of the eastern species of south-western generic types, and *vice versa*.

Remarks on the Nomenclature of some of the South Australian Butterflies, with Observations.

By E Guest.

[Read September 8, 1885.]

Having given much of my leisure time during the last six years to the study of such of the Lepidopterous fauna as are to be found in the neighbourhood of Balhannah, I wish to place some of the results of my observations before the Society.

It is quite a mistake to suppose that butterflies and moths are scarce in South Australia; in places they may be, and the Rhopaloceræ are certainly not abundant in species, but all other families are extensively represented, and only want looking for. As a proof of this I may mention that I have taken nearly 500 species within a radius of three miles of my house, and am continually finding fresh ones. A very fair percentage of these have turned out to be new to science, of course chiefly among the micros, although out of 45 species of Geometrina nine were returned as "not previously described." This makes it very evident that to get anything like a fair knowledge of our fauna we must have more workers, and knowing by experience the disheartening nature of the pursuit, through the difficulty of obtaining correct specific determinations, I thought that I would make an effort to get the nomenclature cleared up, so far as my limited knowledge and opportunities would allow me.

For this purpose I have remitted specimens of all the doubtful species of butterflies that I possessed to Mr. E. Meyrick, B.A., &c., of Sydney, whose kindness and courtesy I cannot speak too highly of, asking him at the same time to identify all that he could of such species as are mentioned in Mr. Tepper's papers, but of which I did not possess specimens. The results of our correspondence I now epitomise in the following list, which I believe is correct so far as it goes, but unfortunately the species of Hesperidæ and Synemonidæ are difficult of identification without specimens, and many of Mr. Tepper's are consequently omitted.

As will be seen, our new species have been ruthlessly cut down—in fact, I very much doubt if there be a single butter-

fly in either list that has not been previously described, and even the number of species given is much understated. The present endeavour may, however, be of assistance to any beginner intending to pursue this subject as a prelude to the more interesting, though more difficult, study of the other families :—

Pieris aganippe (*Don*).—Occasionally seen, but not common, at Balhannah. April and after hybernation, in September.

Pieris harpalyce (*Don*).—The figure of this species represented in Mr. Tepper's paper (p. 3., fig. IV.) is not harpalyce at all, but the male of P. aganippe. The true harpalyce may be at once recognised by the large red spots on the underside which are wanting in the aganippe.

Terias smilax (*Don*).—Common at Balhannah some years, absent in others. October.

Pyrameis itea (*Fabr.*).—Pretty common. March and in the spring, after hybernation.

Pyrameis cardui (*L.*).—Very common.

Junonia velleda (*Fabr.*).—Very common.

Xenica Klugii (*Guerin*).—Very common, but only single-brooded in the hills. October and November.

Xenica achanta (*Don*) ; Las ocrea (*Guest*).—Local, but generally abundant where it occurs. Scarce at Balhannah. November and December.

Heteronympha merope (*Fabr*).—One of our commonest insects out in November. The male soon disappears, but the female keeps about all the summer, but is never, I think, seen the following Spring.

Danais chrysippus.—A rare insect here. March, and hybernates.

Danais erippus (*Cram.*).—I have never taken this insect at Balhannah, but it is very common at Norwood.

Ialmenus ?, spec.—I take one fine species of this genus up here some years not uncommonly, but as yet have not succeeded in getting it identified (perhaps I. icilius). Mr. Tepper's Cupido œneus is also of this genus, but of which species is uncertain.

Lycæna discifer (*Herr Schäff*).—A common insect both here and most places. It frequents open grassy paddocks in this neighbourhood. November.

Lycæna Bœtica (*Lin.*).—Not very common most years ; flies very fast. September and October, and again some years at the end of April.

Lycæna agricola (*Hew*).—Generally common, but not often met with here.

Lycæna erinus (*Fabr.*).—This is Mr. Tepper's Cupido simplexa. It occurs here, but not very commonly, frequenting thick

bushy paddocks in November. The Balhannah specimens appear rather smaller than Mr. Tepper's specimen.

Lycæna alsulus (*Herr Schäff*).—This is Tepper's Cupido delicata, and my L. purvulgatus. Common all the year round. Varies greatly in size.

Lycæna biocellata (*Field*).—Is Tepper's Cupido adamapuncta. A common insect here, and widely distributed, extending to Fiji. November, &c.

Lycæna serpentata (*Herr Schäff*).—This is Cupido fasciola of Tepper, and C. molybdena of my list. It appears to be nowhere very common, but distributed all over the colony, Mr. Meyrick having taken it at Quorn. Out in October, and may be occasionally found all through the summer in grassy places.

Lycæna Heathii (*Cox*).—This is the L. paradoxa of my list; it is not included in Mr. Tepper's. During the last two years I have taken it rather plentifully, and it appears to be widely distributed. Out in October, and I think must be double-brooded as I also take it quite fresh in March.

Ogyris otanes (*Field*).—This is not taken here; but I have included it on Mr. Tepper's authority, as there can hardly be any mistake in such an insect as this.

Trapezites petalia (*Hew*).—This is Hesperilla quadrimaculata of Mr. Tepper. I have not as yet seen it here, but it appears fairly distributed.

Taractrocera papyria (*Boisd*).—This is my Hesperilla fumosa; it does not appear to be included in Tepper's list. Is locally common here, and is widely distributed.

Synemon sophia (*White*).—Is Mr. Tepper's S. læta. It is common here, and is taken all over the colony, but appears to be peculiarly South Australian. The true S. læta is quite a differently marked insect.

Synemon theresa (*Dark var.*).—Is Mr. Tepper's S. obscura. I take it here, but not commonly.

Descriptions of and Notes upon the Species of the Genera Murex and Typhis, known and recorded to Exist on the Coast of the Colony of South Australia.

By W. T. Bednall.

[Read September 8, 1885.]

In presenting this paper to the Royal Society of South Australia I am actuated by the wish to place such information as I have obtained on the subject at their disposal, and also that through this channel the same may be communicated to authors, students, and collectors elsewhere. Mr. G. W. Tryon's "Manual of Conchology," a recent and most valuable work, comprehending all the known species up to the date of publication, has afforded me considerable assistance in checking our own species, but at the same time it has shown me that conchological authors and collectors are still very much at a loss for authentic information as to the habitats and local distribution of many shells; indeed, notwithstanding the zeal with which in these days of scientific travelling and exploration every corner of the globe is ransacked for new treasures, the number of species still with "habitats unknown" attached to them is remarkable. As Conservator of one of the most magnificent collections in the world—that of Philadelphia—Mr. Tryon, has facilities for comparison and reference that cannot possibly be enjoyed by students in distant countries; and the same may be said of the curators of the splendid museums of England and the Continent. But in their limited sphere local collectors have opportunities of doing service to science by distributing specimens and recording personal observations, by which means the many difficulties of identification which so sorely trouble the naturalist will gradually be lessened, and authors will be saved the unpleasantness of again and again giving new names to the same shell. As an instance in point, one of the species included in this paper is fettered with no less than four different names, besides a probable fifth.

We have five recorded species of Murex, four of which are known to local collectors.

Genus Murex, Linnæus.

M. (Pteronotus) triformis.—Reeve, *Conchologia Iconica*, pl. 13, f. 53.—Shell angularly elongate and absolutely triangular

in looking at it with the spire in the foreground; spire two-fifths the length of the body whorl; whorls six, angulated towards the upper part and slightly nodulous between the varices, transversely striated, the grooves increasing in width and ending in a delicate frill on the varices of the body whorl; varices with a single open projection or spine posteriorly both on the spine and body whorls in a line with the nodosities; aperture ovate, but sinuating considerably posteriorly near the outer lip; canal somewhat long, not quite closed, and in most specimens increasingly open towards the anterior end, which is strongly recurved; outer lip finely crenate; inner lip smooth, spreading over the columella; colour fulvous brown, in most specimens increasing to deep purple, while others again are of a creamy white; inside white; length 3 inches, breadth 1.3 inch.

Distributed generally throughout South Australia. Dredged at a depth of from two to ten fathoms in St. Vincent's Gulf.

King George's Sound, Western Australia.

Tasmania, where, however, the specimens are much smaller.

A very pretty shell when in good condition. The varices form an elegant frill nearly the whole length of the shell, which is especially conspicuous on the margin of the outer lip, and, in perfect specimens, the recurved canal becomes a strong hook.

M. (Pteronotus) Angasi.—Crosse (*Typhis*) *Journal de Conchyliologie*, 1863, pl. 1, f. 2, *M. eos*, Hutton, *Manual of New Zealand Mollusca*, 1873.—This small species has the general appearance of young examples of the preceding one, but the varices at their juncture with the suture are very canaliculate and much hooked backwards. In the spaces between the varices are two or three small rounded close canals of varices, giving the shell the appearance of a Typhis, in which genus it was placed by M. Crosse. Last whorl larger than the spire; aperture small, nearly oval; columella arcuated; outer lip large and foliaceous; canal slightly oblique and recurved backwards; length 6, breadth 3 lines.

St. Vincent's Gulf (Tate); Port Lincoln (Bednall).

Tasmania (Atkinson).

Port Jackson, N.S.W. (Angas).

New Zealand (Hutton).

M. (Phyllonotus) octogonus.—Quoy and Gaimard, *Voyage of the Astrolabe*, vol. ii. p. 531, pl. 36, f. 89. *M. scalaris*, A. Adams, *Proceedings of the Zoological Society, London*, 1853, p. 71. *Trophon umbilicatus*, Tenison Woods, *Pro. Royal Soc. Tas.*, 1875. (?) *M. Brazieri*, Angas, *Pro. Zool. Soc.*, 1877, p. 171, pl. 26, f. 3. Shell elongately oval, solid, spire pointed, about half the length of the shell, and a trifle longer than the aper-

ture; whorls 5-6, spirally grooved, rounded, angular at the upper part and slightly concave at the suture; strongly variced longitudinally, the liræ made by the spiral grooves ending in open foliations on the varices of the body whorl, which are eight in number, and terminating in the vicinity of the umbilicus in coarse raised laminæ; outer lip finely notched on the margin and crenate internally; inner lip smooth, spreading over the columella; light fulvous brown, ribs deeper in colour, pinkish inside; length 12, breadth 6 lines.

St. Vincent's Gulf (Tate, Bednall). Kangaroo Island (Tate). "Dredged along with horny zoophytes and nullipores at a depth of seven or eight fathoms" (Angas).

Tasmania (Tenison Woods).

Moreton Bay, Queensland (Strange).

Following Mr. G. F. Angas in his paper on the Marine Molluscan Fauna of South Australia, contributed to the Zoological Society in 1865, I had named my specimens of this shell and catalogued it in this paper as *M. scalaris* of Adams, but Professor Tate has not only kindly shown me the original description and figure of Quoy and Gaimard in that magnificent work the Voyage of the Astrolabe, but a very perfect and beautiful specimen obtained by him at Kangaroo Island; also a very large fossil example from the Tertiary formation of New Zealand. From the comparisons made I feel sure that there can be no doubt of the identification of the South Australian shell with *M. octogonus*. In New Zealand the species attains twice the size it does in these waters, and in the type specimen figured by Quoy the foliations on the varices are much more prominent. Mr. Tryon reproduces Quoy's figures in his Manual of Conchology, vol. ii., pl. 30, figs. 272 and 273. He also gives a representation of *M. cuspidatus*, Sow. (fig. 24), which he says is a synonym. This more nearly represents our form than the original. By rejecting the synonyms of Adams and Woods it will be seen that the shell under review is recorded from South Australia, Tasmania, New Zealand, and Queensland, but not from New South Wales; the description and figure of the *M. Brazieri* of Angas, noted above, from that part of the Australian coast, answer so closely to *M. octogonus* that there is little room to doubt that it is that species described from an immature shell.

In the Manual of Conchology before referred to Mr. Tryon has expunged the M. *scalaris* of Adams, and substituted for it the name of *M. Angasi*, adding the following remarks;—"Said to resemble *M. cristatus*, Brocchi. Possibly identical with *M. octogonus* (Quoy et Gaim). As Brocchi has used the name for a fossil species, this may be known as *M. Angasi*." There was little occasion for Mr. Tryon to rename *M. scalaris*, as

apparently he himself had small doubt of the shell being referable to *M. octogonus*; besides his work contains (only a few pages previously) the description of the *Murex Angasi* of Crosse.

M. (Ocinebra) pumilus.—A. Ad.; *Pro. Zool. Soc., Lond.*, 1863, p. 70.—Shell small, fusiform, imperforate, with distinct rounded (about eight) varices extending the whole length of the shell crossed by fine transverse liræ ending abruptly on the outer lip; whorls four to five rounded; aperture oval, attenuated anteriorly, inner lip smooth; outer lip waved in answer to the exterior liræ; colour grey, but worn specimens are a delicate flesh colour both outside and in; length, 4½; breadth, 3 lines.

MacDonnell Bay, Fowler's Bay (Tate). Henley Beach, Semaphore, Aldinga (Tate, Bednall). East side St. Vincent's Gulf (Angas). Also received by me from Port Lincoln.

In some specimens the transverse liræ are more prominent than the varices, giving the shell at a superficial glance the appearance of a different species.

Both the *M. pumilus* of Kuster and *M. pumilus* of A. Adams are figured in Tryon's work, the former in pl. 36, f. 413 and the latter in pl. 38, f. 470, but neither of the figures really represents the shell which I have here described.

M. serotinus—A. Ad.; *Pro. Zool. Soc., Lond.*, 1851, p. 268.

One specimen obtained (alive) amongst the rocks at low water spring tides, Aldinga Bay (Angas). Not known to local collectors.

Mr. Tryon has been unable, from the meagreness of the original description and the absence of any figure of the shell, to place this species in any of the sub-generic groups; and in his Manual of Conchology he has included it in a list of indeterminate species. Mr. Sowerby, the same work states, affirms that the shell is synonymous with *M. Blainvillei*, Payr., a Mediterranean form.

Genus Typhis, Montfort.

Typhis Yatesi.—Crosse, *Journ. de Conch.*, vol. xiii., p. 54, pl. 2, f. 3.—"Shell imperforate, subquadrangular, elongately oval, somewhat thin, translucid, white in colour, slightly tinged with pink; whorls six, each one bearing four flexuous compressed jagged varices, terminating in a hollow sharp and recurved spine when perfect, in the spaces between the varices a prominent simple tube; canal entirely closed from the aperture to the base, somewhat large, slightly oblique and recurved. Length fourteen millimetres, greatest diameter seven. This species is easily distinguished from its congeners by the elegant denticulation of the varices."—*Crosse.*

Holdfast Bay, Semaphore, St. Vincent's Gulf (Angas, Tate, Forwood, Bednall). Stansbury (Tate). Somewhat rare.

A Few Remarks About Weather Forecasting for South Australia.

By W. Ernest Cooke, B.A., Acting Government Astronomer.

[Read Sept. 8th, 1885.]

The comparatively recent science of meteorology has advanced sufficiently far to become of considerable practical benefit to mariners, farmers, and all those whom the question whence the storm cometh and whither it goeth vitally affects. Having recognised the great strides that have lately been made, a number of persons seem to think that now it is a comparatively easy matter to forecast coming weather for one or two days ahead with absolute certainty; and, in fact, several letters and articles have appeared recently in various colonial papers taking up this view of the case, and causing many to wonder why, under the circumstances, reliable weather forecasts are not issued in the daily papers. I wish, in these remarks, to place before the Society a few considerations as to the reasons why such a desirable result cannot at present be brought about, as far as South Australian weather is concerned.

The manner in which a number of the aforementioned articles refer to this matter indicates a misconception. They liken the approach of a cyclone from the westward to the advent of a railway train whose times of passing the successive stations are duly telegraphed. It passes Albany at a given time, Esperance Bay some hours later, and Eucla a certain number of hours later still. Now we have only to make a very simple calculation in order to find out the exact time it will pass, say Adelaide. The only meteorological reports that are necessary are those from, say, Albany, Esperance Bay, and Eucla, and all within reach of a daily newspaper ought to be informed with absolute certainty of the state of the weather two or three days ahead. Yet this is not done. Why? Possibly there are one or two premises, stated or inferred, in the above argument that are to a certain extent unsound. First of all, we say a depression passes Albany at a certain time. Who is to tell that? I suppose Albany is one of the most impossible places in the world to state with any certainty that a depression has passed eastwards. The winds there seem to be almost always westerly, so they can be no guide to the direction of the central depression; and the barometer is so differently affected there from other places along the coast that

it by itself offers no sure guide. Very often Albany will report a sudden fall of half an inch in twenty-four hours, while other places will be entirely ignored by the depression. Then again suppose we are satisfied, from a concurrence of reasons, that a storm centre lies to the south of Albany, we have no guide whatever as to what its movements will be. By mapping out the whole of Australia and New Zealand with isobaric lines, as is regularly done every morning, we can perhaps infer to a certain extent that certain particular movements are unlikely. If, for instance, an anticyclonic area, or a region of high barometers, were lying over south-eastern Australia, and another over, or to the west of New Zealand, the normal winter high pressure being over central Australia, while a low pressure was noticed to the south or south-east of the Leeuwin, we would have fairly good reasons to suppose that the said low pressure would not move eastwards for a time, until some changes had taken place in the conditions over south-eastern Australia and New Zealand. But when no such decided barriers are opposed to a storm's progress, it is not always easy to say in what manner one that is supposed to be off the Leeuwin will act. Sometimes it will come steadily eastward, sometimes south-east, sometimes shoot up into the Great Bight, and after an indefinite time travel south-east, sometimes southward, sometimes remain where it is, and sometimes all trace of it will disappear during the course of a day.

The most serious difficulty with which we have to contend lies in the fact that almost all the storm centres keep well to the south of the continent. We have thus very often no sure guide as to the distance of this centre, no exact knowledge of the shape of the isobars, even on the northern quadrants, none whatever on the southern, and no idea of the state of the atmospheric pressure to the south-east, south, and south-west, to give reasonable grounds for assuming the centre will move in any given direction, or with any given velocity. When we have managed to satisfy ourselves that a disturbance lies a little south of Eucla, as a general rule we notice that the time of lowest pressure will occur at Adelaide about 20 to 24 hours later, but sometimes the minimum readings occur almost simultaneously at the two stations. There is, however, a very large percentage of storms that once fairly seen to be on their way past Eucla will reach Adelaide in from 12 to 24 hours.

Another difficulty occurs. Suppose we have noticed a storm centre pass Eucla, after having previously traced it past Albany and Esperance Bay, and have noticed that it is a perfectly steady and business-like storm, proceeding onward composedly and regularly in its work of destruction or otherwise, and we can be pretty certain that Adelaide will have a

minimum barometric pressure within the next 24 hours, and Cape Northumberland some six or twelve hours after. Even in such a case as this, it is not always positively certain that a given kind of weather will follow. There are, of course, certain rules as to the kind of weather we may expect at different parts of a storm's path. These are purely empirical, and have been collated from observations made on Australian storms since the establishment of the Western Australian telegraph. Any rules that have been previously discovered in the northern hemisphere have been found to be of no practical use for application here. We find that we must carefully investigate as far as possible our own storms, and find out empirical laws therefrom for our practical guidance. As a matter of fact, one rule seems to be pretty firmly established—that with a certain class of depressions, occurring mostly in winter, the weather is fine a long distance ahead of the coming storm; as the centre approaches the sky becomes clouded over first with cirrus, then cumulus, or rather cumulo-stratus. Light rain sets in some time before the lowest pressure, and while the wind is still light from the north; but after the lowest pressure has passed the wind veers to the S.W., the clouds change into scattered watery cumulus, nimbus, and scud; the wind blows strongly, and the rain descends in heavy showers. I think I may say that this is the usual type of winter depressions; at all events, most of those during the late winter have been of this sort. But, then, the light rain preceding the centre sometimes starts two days, sometimes only a few hours, prior to the passage of minimum pressure. Sometimes the light rain is absent, and we experience a strong northerly gale. Sometimes the weather clears almost directly after the passage of the centre, and sometimes remains showery for a week. We might think it would be very easy to tell what particular sort of weather was connected with any particular part of the movement by noting the change at the various western stations as the storm centre passed them. But suppose Albany reports fine weather almost up to the time of minimum pressure, followed by very heavy rain, Esperance Bay heavy rain followed by scattered showers, and Eucla a strong northerly gale with no rain and a veer to west or south-west with fine weather after the passage, while Streaky Bay and Port Lincoln report threatening weather, it is rather difficult to say with any degree of certainty which of these different phases will be presented as the disturbance passes Adelaide. We are never at all sure of a depression until Eucla shows indubitable signs of its presence; but when once it has passed Eucla it is almost certain to travel eastward or south-eastward, and thus for a large number of storms we have warning at least twelve hours in advance.

I think it would be premature to issue forecasts at present until we get to more thoroughly understand the behaviour of storms between Leeuwin and Eucla, and the only way to do this is by careful inspection every day of isobar maps of the entire continent, such as are displayed in the hall of the Post-office, and by carefully noting the weather accompanying certain recognised forms of disturbance. Melbourne is much more favourably situated than we for forecasting, since, as I I have pointed out, storms are to a great extent regular in their passage after passing Eucla, and thus observers at Melbourne have very often a good thirty-six hours' warning at least. Of course a number of circumstances may easily tend to render a forecast at Melbourne incorrect—such, for instance, as the case of a storm-centre off the south of Tasmania moving up or expanding northwards. This has happened on several occasions, and of course no warning of this could possibly be obtained. The cause of such a movement would probably be found far away in the Southern Ocean.

As a matter of fact, forecasts are published regularly in the *Argus* by the Victorian Government Astronomer, and, I believe, are to a very great extent trustworthy. With our present knowledge of the general laws of storms, and the behaviour of certain particular types of Australian cyclones, I believe it would be possible to issue forecasts for twenty-four hours ahead, of which a large percentage would be correct. Owing to the difficulties I have pointed out, however, the forecasts could not be absolutely depended on; but we may look forward confidently to some time in the near future when fresh discoveries and more elaborate research will enable the practical meteorologist to foretell with comparative certainty the coming climatic conditions for one, two, or three days, if not for weeks.

Additions to the Flora of Extra-Tropical South Australia, including Descriptions of Two New Species.

By Professor Ralph Tate, F.G.S., F.L.S., &c.

[Read October 6, 1885.]

Dysphania simulans, *F. von. Mueller* and *Tate.*

Erect, stemless or very short stems or branches from the root, densely beset with short glandular hairs; leaves conspicuously stalked, ovate-oblong, cuneate at the base, wavy at the margin or bluntly short-lobed; flowers in elongated leafless, dense, simple spikes; segments of the calyx three, somewhat scarious, inflated, prominently angular in front and at the margin, pointed at the summit, closing valvularly together over the fruit, the lateral angles membranous, not fringed; tube of the calyx semiovate, papillular; stigmas two, subtle-capillary; fruit spherical, pale-brown, smooth, translucent; embryo nearly semicircular.

Gypsum, salt-flats, Cootanoorinna, on the west side of Lake Eyre; *Malcolm Murray.*

This plant simulates in a remarkable manner the *D. plantaginella, F. v. M.*, so much so, that without careful inspection it might be passed for that species; but the leaves are provided with slender stalks and sinuated margins, the flowers are larger and not so readily falling off in age, the bracts less developed, the segments of the calyx are almost deltoid, not obovate, not thinly attenuated, but connate into an almost hemispheric base, which partly encloses the fruit; the latter is broader, not ovate, the raphe forming a broad dark-brown band. Some approach of the genus *Dysphania* to the section *Orthosporum* of *Chenopodium* is established by this species, as will be noticed by a close comparison of *C. atriplicinum* and particularly *C. cristatum.*

Trianthema turgidifolia, *F. v. M.*; Frag. X., p. 83, 1876. Interior. *F. v. M.*, in 2nd Supplt. Census Aust. Plants.

Crotalaria Mitchelli, *Bentham.* Strzelecki Creek. *James Macleod!*

Loranthus gibberulus, *Tate.*

Branches and foliage hoary-tomentose; inflorescence woolly-tomentose. Leaves alternate or nearly opposite, terete, stout, erect, mostly two inches long. Flowers axillary, pedicellate,

in pairs, or the common peduncle bearing two rays, each with two pedicellate flowers. No bracts. Calyx border deeply cup-shaped, truncate; bracteole gibbous adnate to the calyx tube. Petals four free, narrow, woolly externally, glabrous and dark red interiorly, one to one and a half inch long, dilated apex of bud tetragonal. Anthers adnate, oblong linear. Style filiform, nearly as long as the corolla. Fruit not seen.

Parasitic on *Grevillea nematophylla*, which is restricted to the "gypsum rises" of the William Tableland, Lake Eyre basin, west. *Malcolm Murray.* Flowering in April.

This new species has a general agreement with *L. linophyllus*, and especially with *forma c.* (*Bentham*), having woolly-tomentose flowers, but it differs by its cup-shaped calyx border, stouter habit, tomentose investiture, and by the gibbous base of the calyx-tube. It resembles *L. Quandang* by its investiture, but the leaves, calyx, and pedicellate flowers are different.

STYPHELIA (LEUCOPOGON) COSTATA, *F. v. M.*, in Southern Science Record, April, 1885. *S. striata*, *Tate*, Trans. Roy. Soc., South Australia, vol. VI., p. 166 (*non.*, *Sprengel*). Kangaroo Island.

STYPHELIA (LEUCOPOGON) STRIATA, *Sprengel.* Eucla (*teste*, *F. v. M.*)

XANTHORRHÆA TATEANA, *F. v. M.* *X. quadrangulata*, *Tate*, Trans. Roy. Soc. South Aust., vol. VI., p. 168 (*non.*, *F. v. M.*). Kangaroo Island. Probably Mount Crawford Swamps, near Williamstown; and the Black Swamp, District of Encounter Bay.

I. On the Persistency of Electric Currents in Masses of Iron.

II. The Cause of the Luminosity of Flame.

By Prof. H. Lamb, M.A.

The following abstracts form the substance of some remarks, accompanied by experiments, delivered by Prof. Lamb before the Society on the evening of March 3, 1885, *with supplementary remarks by Prof. Rennie :—*

On the Persistency of Electric Currents in Masses of Iron.

Professor Lamb showed some experiments illustrating the gradual decay of electric currents circulating in a cylindrical bar of iron, and subject only to their mutual induction. A bar of iron two inches in diameter was surrounded by two coils of copper wire, which may conveniently be called the primary and the secondary coil. A steady current from a battery is made to circulate round the primary coil, and so magnetise the iron bar. This circuit being suddenly broken, currents are induced in the bar, which tend to maintain its magnetism. The decay of these currents and of the accompanying magnetism produces a gradually diminishing electromotive force of induction in the secondary coil, which is in circuit with a sensitive mirror galvanometer. The intensity of this electro-motive force at any instant after the break of the primary may be estimated by closing the secondary circuit, which is previously open, and observing the first swing of the galvanometer needle. The breaks and makes were made by means of an Attwood's machine, and the interval between the "break" of the primary and the "make" of the secondary could be varied. In the actual experiments this interval was increased by successive steps of ·15 of a second. In this way the gradual decay of the currents in the iron can be traced without difficulty for over $1\frac{1}{2}$ seconds from the time of the original break. According to theory the persistency of the currents is proportional to the square of the diameter of the bar, so that for an iron cylinder a foot in diameter the corresponding interval of time would be about a minute. Some account of the above experiments was given to the Society nearly two years ago, but the experiments have recently been repeated with various improvements in the method of observation, and the author

hoped soon to be able to lay the final results before the Society.

On the Cause of the Luminosity of Flame.

Professor Lamb called attention to a very interesting discussion which had recently taken place on the above subject in Germany. Luminous flames are of two kinds. In the first kind—for example the upper part of the flame of a candle or of an ordinary gas flame—we have an intense white light, caused, as is generally held, by particles of solid carbon shining in virtue of their high temperature, just as an iron bar becomes white hot if its temperature be sufficiently raised. It is fair to mention, however, that this explanation has been called in question, but the balance of evidence seems on the whole decidedly in its favour. The discussion to which Prof. Lamb wished to call attention had reference to the second class of flames, where we have a gas shining with a light (generally faint) of its own, and containing no solid particles. An instance is the flame of a Bunsen's burner well supplied with air. It is generally supposed that this light is simply due to the fact that the gas is at a high temperature; that in the chemical processes of combustion a certain amount of heat is set free, which has the effect of raising the temperature of the gas; and that the luminosity is a secondary effect due to the rise of temperature. This view has been recently called in question by W. Siemens, of Berlin, who finds that air and some other gases may be raised to a temperature considerably above that of the Bunsen flame without becoming in any degree luminous. The observations were made at night on the air, &c., contained in an oven, used in the manufacture of hard glass, the walls of which could be raised to a temperature above that of melting steel. The line of vision passed through two opposite apertures in the walls, and care was taken, by arranging suitable screens, that no light from the walls themselves should reach the eye. Siemens suggests that the light of the Bunsen flame is a direct result of the chemical changes which are going on, and has nothing to do with the temperature of the gas. It is, in fact, conceivable that the violent tearing asunder of the molecules and the rearrangement of their constituents in other combinations may give rise to disturbances in the luminiferous ether. This explanation is supported by the fact that if care be taken to secure a more intimate mixture of the air and other gases before combustion the flame becomes shorter, although much hotter, the chemical processes being completed within a shorter distance from the nozzle. If the light were the result of the temperature, then the flame ought to become longer instead of shorter, for the

gases could move away further from the nozzle before cooling down. The views of Siemens are supported by the observations of E. Wiedemann and of Hittorf on the passage of electricity through rarefied gases. E. Wiedemann has found, by a direct measurement of the heat developed that a gas may become luminous under the influence of an electric discharge whilst its temperature is considerably under the boiling point of water. Hittorf, by means of a powerful bichromate battery of 2,400 cells, obtained an apparently continuous current through a glass tube containing rarefied gas. On some occasions the gas was luminous whilst the tube was not too warm to be touched by the hand without inconvenience. This is, of course, quite inconsistent with a high temperature of the gas. In another experiment the current was led by iridium terminals into a tube, and a dark space was observed round the positive terminal. This terminal became so hot that the metal softened, glowing with an intense white light, whilst the gas immediately in contact with it (and therefore at a very high temperature) was quite dark. We have, then, very strong evidence that gases can become luminous under the influence of electrical processes, independently of a rise of temperature; and considering the very close relations between electrical and chemical actions, it is not surprising that the same should be true of chemical processes, such as we meet with in combustion.

Professor Rennie then made some remarks on the cause of the luminosity of the first class of flames mentioned by Professor Lamb:—The usually accepted theory regarding the luminosity of an ordinary candle or gas flame is that it is due to the presence of solid particles of carbon at a white heat. Some years ago Professor Frankland made some experiments which he thought disproved this theory. He showed that intense light can be produced under conditions which, as he believes, excluded the possible presence of any solid particles —for example, arsenic burning in oxygen. In this case it is said that the temperature of the flame is such that the arsenic itself and the products of its combustion must be in a state of vapour. He showed also that certain non-luminous flames become luminous under increased pressure. He ascribed the luminosity of ordinary flames therefore to the presence of very dense hydrocarbons at a very high temperature. He was confirmed in this belief by the transparency of such flames and by the fact that the soot deposited on cold substances placed in the flames was not pure carbon, but contained hydrogen. Since Frankland's experiments were made other scientists, chiefly in Germany, have investigated the subject, with the result that the original theory has been confirmed for the

following reasons:—1. Ordinary flames cast a shadow in sunlight, and it is difficult to believe that this can happen except by the intervention of solid particles; and carbon is the only solid substance which can be present. 2. Flames artificially made to contain solid particles have been shown to be as transparent as an ordinary gas flame. 3. If there be only heated vapour in such a flame, soot ought not to be deposited on a strongly heated rod held in it, whereas, as a matter of fact, soot is deposited under such conditions. 4. By causing one flame to meet another the particles of carbon may be made as it were to agglomerate, and a much coarser-grained soot is obtained. 5. The quantity of hydrogen in soot is extremely small, very much less than in the densest hydrocarbons. The small luminosity of a Bunsen flame has been usually ascribed to the complete combustion of the solid particles of carbon, but it has been shown that the previous admixture of nitrogen and other inert gases with the coal gas renders the flame almost non-luminous. This is probably due to the lowering of temperature produced by the admixture of a large volume of inactive gas, for the luminosity can be restored by heating the mixture before burning. In a Bunsen flame the added heat due to increased combustion probably overbalances the cooling effect of the admixture of air. That the heating of gas before it reaches the burner greatly increases the illuminating power is well known, and this principle has been applied practically in recent improvements in gas-lighting in England and Europe.

The Apricot Disease.

By F. S. Crawford.

[Read November 4, 1884.]

Two years ago I forwarded to Dr. M. C. Cooke leaves and fruit of the apricot—the former attacked with the "Shot-hole Fungus," and the latter with the pustular disease on the fruit, both which have been so common of late. I likewise mentioned that I thought there was a relationship between the two fungi. In reply Dr. Cooke stated that the shot-hole fungus was *Phyllosticta circumcissa*, and the pustular disease was caused by *Helminthosporium rhabdiferum*, and that the two fungi were entirely distinct.

Observations made during the last and present seasons have strengthened my suspicions that the two fungi are connected, and this opinion has been confirmed during the last few days by discovering several specimens of the shot-hole fungus on almond leaves in a state of fruit, the spores of which are precisely similar to those of the apricot fruit fungus, and which in shape resemble an *Helminthosporium*, and not a *Phyllosticta*.

In spite of the prevalence of the shot-hole fungus on the almond, cherry, plum, apricot, &c., it is a rare thing to find it showing spores. One day I discovered several spots on an almond leaf abounding with spores, but the next day failed to find any after a prolonged search, although to the naked eye the spots seemed precisely similar, and the leaves were taken from the same part of the tree. This may be owing to either the fruit spores growing very rapidly, and as quickly falling off, or else that a spore falling on a leaf gives rise to a mycelium, which grows, making the characteristic brown spot that soon drops from the leaf, but which only under exceptional circumstances produces spores in that stage of its existence.

In looking over Dr. Cooke's letters I am inclined to think that in naming the shot-hole fungus a *Phyllosticta* an error was accidentally made, because several other fungi were forwarded at the same time, and it was quite possible that one was a *Phyllosticta*; and as *P. circumcissa*, according to Cooke, makes shot-holes in the leaves of many plants, the mistake might thus easily arise. I also wish to point out that *Helminthosporium rhabdiferum*, according to "British Fungi," is found on ripe peaches, whereas I have never seen a peach, ripe or unripe, attacked with the "pustular eruption," although the leaves are to a slight extent affected with the "shot-hole"

fungus. I am, therefore, inclined to think that this disease is not the true *H. rhabdiferum* but an undescribed, species of *Helminthosporium.*

From an economic point, the fact of the shot-hole fungus and the apricot disease being the same is of importance. As the disease appears first on the leaves before attacking the fruit, it shows the necessity of combating the disease in this early stage, as well as not allowing comparatively valueless trees that are diseased to remain near young and healthy ones.

The following is the description of the spores of the shot-hole fungus:—Obovate or sub-fusiform, ·0014 inch long by ·00056 inch broad in centre; a single spore at extremity of a short peduncle from which it readily parts; of a very pale greenish-brown colour, almost hyaline; mostly tri-septate, many bi-septate, and a few 4-5 septate.

[December, 1885.—I take advantage of the proof of the above being forwarded for correction to add a few remarks. I found that during last winter, before all the almond leaves had fallen, that in the centre of the roundish-brown spots were generally to be found one or more tufts of a light brown colour, about $\frac{1}{120}$ inch in diameter, and which consisted of a great number of these spores growing on their peduncles. In early summer these tufts no longer appeared, although the brown discoloured spots became more numerous, which soon falling out formed the characteristic shot-holes. As soon as the fruit of the apricot begins to form, one or more very minute specks may be observed, but always on the upper side of the fruit; these specks increase in number and size until they make the brown scabs or "pustular eruptions." The scabby fruit is always most prevalent on trees that are most attacked with the shot-hole fungus, and always worse where the leaves are thickest over the fruit. Mr. Tepper informs me that Professor Ludwig, of Germany, had decided, from some almond leaves he had sent him, that they were attacked with *Sporidesmium amygdalearum*, but as Mr. Tepper is doubtful whether the Professor saw any spores, and as he was not aware of the supposed connection of the shot-hole fungus with the "pustular eruption" on the apricot, and as, moreover, the spores above-mentioned do not answer the description of a *Sporidesmium*, I am still of opinion that it is a true *Helminthosporium*.—F.S.C.]

On the Fossil Foraminifera from the Government Boring at Hergott Township, with General Remarks on the Section and on other forms of Microzoa observed therein.

By Walter Howchin, F.G.S.

[Read December 2, 1884.]

A short time ago a small quantity of material obtained from the Government boring at Hergott was placed in my hands by Professor Tate to examine in the hope that a careful search might reveal some forms of microzoa by which, at least, the marine character or otherwise of the beds through which the boring was carried might be determined. Mr. Clement L. Wragge, to whom Professor Tate was indebted for these samples, kindly added to their quantity. I am also placed under great obligation to Mr. Jas. W. Jones, the Conservator of Water, for his ready courtesy and liberality in placing other samples of the core at my disposal. By this means I have been enabled to test the microscopic contents of this geological section throughout its entire depth. The figures indicative of the various depths from which the samples were taken, I regret to say, are rather vague, but are the best information as to their respective geological horizons which was at my disposal; but this is of less consequence on account of the great uniformity of the beds through which the bore passed.

I would also acknowledge my indebtedness to the great work of my friend Mr. Henry Bowman Brady, F.R.S., on the Foraminifera of the Challenger Expedition, which has just been published by the British Government. When we take into account the great number of new species therein figured and described, the fulness of information on this particular field of zoological investigation which it supplies, and the new facts as to the distribution and bathymetrical range of the marine Rhizopoda, which are now for the first time made public, the work must rank as one of the most important contributions to the history of the Foraminifera that has ever been published. Mr. Brady has found it necessary, in working out the enormous quantity of new material which was placed in his hands, to rearrange some groups, and this necessitated some change in the nomenclature. I have in the following remarks adopted Mr. Brady's classification, which will un-

doubtedly be generally accepted by workers in this department of natural history.

Nine samples of material were washed and searched, in all, from the Hergott bore, on which the following remarks may be made:—

Remarks on the Section.

1. *Surface Bed.*—The surface, according to a sample submitted to me by Mr. Wragge, is a bed of loose sand, reddish in hue, and passing from very fine particles up to a shingle of small pebbles. The fragments are mostly quartz, and are for the most part rounded by attrition. The quartz presents the features of the transparent and milky varieties, and are often stained with iron. One or two organic remains were found in this sample when placed under examination. One of these was the single valve of a very minute bivalve shell, much weathered; also a small concave and hemispherical body, finely foraminated on its convex side; and in addition to these a few arenaceous tubular objects, the zoological character of which it is very difficult to determine. The lithological features of this surface bed are so widely different from the underlying that it evidently represents a totally different condition of things in its deposition. It may be after all only an alluvial wash, with a few organic remains mixed with the gravel, these having been derived from older beds. It would be interesting to know the exact thickness of this surface bed, and whether its parting from the underlying great silt bed is a sharply-defined line, or whether the finer silt of the lower passes gradually into the coarser beds that overlie it. The next sample, which is marked as only fifteen feet in depth, shows the passage from the one to the other at that depth to be complete.

2. *Fifteen feet from surface.*—A very fine argillaceous silt with a small proportion of mica. Has a compact appearance in its natural state, but goes down easily in water, and then swells out to several times its former bulk. The residuum left after washing the material and running off the light, flocculent particles, is exceedingly small, and is reduced to about one-twentieth of its original weight. Although no signs of organic remains could be detected in the mass before treatment, the results obtained after washing the material were very interesting. There are few objects of an organic nature present in this sample except Foraminifera, a single Entomostracan carapace and a trace of vegetable tissues making up the number. The Foraminifera are represented by ten species, one of which, *Pulvinulina elegans*, d'Orb., has only been found in the section at this depth, and there but a single specimen; the rest are all arenaceous forms.

3. *Twenty to forty feet from surface.*—The stratigraphical and lithological features of this sample correspond almost exactly with the preceding, having, perhaps, a slightly larger proportion of micaceous particles. Residuum very small in quantity. Under the glass this is shown to consist mainly of small flakes of the matrix not dissolved by the washing, and a considerable number of fragments made up of very minute crystalline particles. The majority of these are apparently aggregations of crystals; but scattered amongst the material are a few objects somewhat similar in appearance to these crystalline bodies, because built up of like particles, but of organic origin. These coarsely-arenaceous Foraminifera, of which there are seven species recorded from this washing, make up nearly the whole of the fossil contents from this depth. The remainder consist of one or two very minute fragments of carbonaceous matter and a few other fragmentary objects, probably of organic origin, but too imperfect to show their zoological relationships.

4. *Forty to fifty feet from surface.*—The general features of this sample resemble very closely the preceding, being evidently a continuation of the same bed of argillaceous silt. Seven species of Foraminifera occur, none of which are peculiar to the geological horizon. This sample is, however, of some interest in supplying a single valve of *Lingula* and two other fragments, which appear to belong to the same species. It is so small a shell as to require a magnifying glass to determine its character. The only other objects worty of note are a detached cell of a polyzoan (the only indication of polyzoanal life found in the entire section), small fragments of drift-wood, a (?) seed case, and a few pyritous casts which are globular or cylindrical in shape, the latter are straight, serpentine, and rarely bifurcating.

5. *Fifty to fifty-five feet from surface.*—Lithological character similar to preceding. The amount of material operated upon from this depth was very small, but moderately rich in its foraminiferal contents. These latter belong to eleven species under seven genera. A trace of molluscan remains was observed in the form of one or two small shell fragments; also one Entomostracan, several seed or egg cases of a brown colour, and small fragments of vegetable matter.

6. *One hundred to two hundred feet from the surface.*—The material from this depth placed at my disposal consisted entirely of the casts of a molluscan bivalve, about the size of a cockle shell. One or two of the least perfect of these casts were dissolved in water, and these left a rather larger proportion of residuum than usual in these washings, in consequence

of the somewhat stronger character of the matrix. This less degree of solubility appears to be owing simply to the distribution of small crystals of iron pyrites scattered through the mass and binding it together. The amount of material thus searched was very small, yet it proved to be the richest sample in its palæontological contents of the whole section. The Foraminifera number thirteen species, in no less than nine genera. Two genera are peculiar to this particular geological horizon—*Verneuilina polystropha* and *(?) Endothyra Bowmani*, the latter a characteristic Carboniferous form, of which we shall say more presently. The associated remains consist of fish bones, including several split vertebræ, a highly decorated Entomostracan, comminuted shells of mollusca, and some vegetable matter.

7. *Two hundred feet from surface.*—A separate sample thus labelled was supplied to me by Mr. Jones. This contains but three species of Foraminifera, but of these *Cristellaria rotulata* is peculiar to this washing, and it is also the best horizon for *Marginulina*. Next to the Foraminifera the most interesting feature of this material is in the occurrences of several fragments of *Dentalium*, a gasteropodous mollusc which has a wide range in geological time. There are also indications of bivalves, fish bones, and a few small cylindrical casts. [Three additional species have since been determined from this depth from mountings submitted to me by Mr. G. Goyder, jun.]

8. *One hundred to three hundred feet.*—The great silt bed appears to be little altered in character even at this depth. The fossil contents are few and weathered. Only three species of Foraminifera were noted. One of these—*Marginulina*—appears to be limited to about this depth, as it was only noted in this and the preceding sample. A few molluscan fragments also occur.

9. *Three hundred and four feet to three hundred and six feet from surface.*—In this washing a marked change in the stratigraphical character of the bed is apparent. The matrix is still a fine argillaceous silt, but it is studded with a large number of small stones and pebbles, mixed with quartz and a green mineral, which is probably glauconite. The enclosed pieces of rock are much water-worn, and indicate a littoral deposit formed in close proximity to land. In consequence of the large proportion of insoluble material in the rock stuff, the residuum left from washing was much greater than in the previous samples. Organic remains at this depth are very scarce, but the relatively greater proportion of residuum may partly account for this apparent scarcity of organic remains. The Foraminifera are represented by only four species, and

these were for the most part single examples of their kind. In addition to some irony-looking casts there occur a few fragments which carry the lustre and colour commonly seen in fossil bone. An examination by sections of a considerable number of specimens of this kind, in this and the following sample of material, has led me to conclude that they are shell remains of an unusual colour. Some of the fragments appear as though they had been perforated by some boring annelid. There was also found in this sample a fragment which belongs probably to the calcareous algæ.

10. *From three hundred and six feet to three hundred and nine feet from surface.*—This, like the preceding, is evidently a littoral deposit, and the two samples must be stratigraphically associated. When examined under a lens it is seen to be made up almost entirely of a fine-grained sandstone that has been broken down by some denuding forces and subjected to attrition. The sand grains are for the most part very small, and have evidently been derived from a soft sandstone that formed the shore line. Some of the fragments of rock enclosed in this bed are white and others of a greenish hue, the latter being in sufficient quantities to give a decided greenish cast to the bed. The organic remains are few. The most numerous of these consist of the smooth and polished objects referred to in the preceding sample, and these show evidences of wave action in their abraded edges. Only two species of Foraminifera occur, but one of these, *Placopsilina cenomana*, d'Orb., is peculiar to this sample, and forms an interesting addition to the list.

Remarks on the Species.

Hyperammina vagans, Brady.—This is an arenaceous Foraminifer, possessing an undivided and unbranched tube which follows most tortuous lines, being often coiled on itself, not unlike some marine annelid growths. It possesses a primordial chamber of a round or oval shape, which is inflated and slightly larger than the tubular extension. In the Hergott material there is one example of the tube coiled and two examples of the primordial chamber which are of an oval shape. The collection made by the Challenger shows that this species has an almost universal distribution in the seas of the present day—from Spitzbergen to Kerguelen Island. It seems to prefer a cold habitat, as in the Arctic seas it comes within fifteen fathoms of the surface, whilst in the great ocean depths it was dredged from a depth of 2,900 fathoms, where a similar Arctic climate prevails. This form has been recently found in the Jurassic rocks of Switzerland by Dr. R. Haeusler, and has been described and figured by him in the "Quarterly Journal of the Geological Society" (Feb. 1, 1883). There is also a

strong probability this this species occurs as a Silurian fossil, as Messrs. Nicholson and Etheridge, in their monograph on the Silurian fossils of Girvan, in Ayrshire, have described a tubular organism which Mr. Brady considers to be none other than the species now under consideration. Its simple structure gives probability to its being an archæan type, and the wide distribution of the form at the present day shows it to be capable of a ready adaptation to varying conditions. Its obscure character and close resemblance to other zoological types may be the reason why it has been completely overlooked as a geological species until recently.

(?) Thurammina papillata, Brady.—*Thurammina* is a new genus founded by Mr. H. B. Brady to include some single-chambered and arenaceous Foraminifera which usually show more or less perforated papillæ on their exterior surfaces. This species is often spherical, but is subject to great variation in outline. In the Hergott material there are a few spherical and arenaceous Foraminifera which we have referred to this genus. The papillæ are not very well defined in the examples I have obtained, but they show a pimpled surface suggestive of papillæ. Their less perfect appearance may be caused by the compression to which these, as well as nearly all the species from Hergott, have been subject. More perfect specimens might indicate that these forms belong to some closely-allied genus, but for the present they may be classed with some reserve as above. *Thurammina papillata*, like *Hyperammina vagans*, is a denizen of all seas at the present day where deep water occurs, but is not often found at less depths than 500 fathoms. Dr. Haeusler found this species associated with *Hyperammina vagans* in the Jurassic rocks of Switzerland, already referred to, and it is rather curious that a similar assumed companionship in these two genera should have occurred in the case of South Australian palæontology.

Reophax scorpiurus, Montfort.—The genus *Reophax*, as now defined by Mr. Brady, includes all the free, non-spiral, and non-labyrinthic *Lituolæ*. The general characters of the genus are a coarsely arenaceous test, with a single inflated chamber, or a number of such chambers strung together in a series, which may be either straight or crooked. *Reophax scorpiurus* is so named from its supposed likeness to a scorpion, having a tapering and often upturned end. It is represented in the Hergott material at three distinct horizons, all under 200 feet. It is by no means a common form in any of the washings, being more generally represented by its starved variety, *R. fusiformis*, to be referred to presently. In existing seas *R. scorpiurus* is widely distributed, and generally pretty common where it occurs. It has an equally wide bathymetrical range, and seems

at home in either hot or cold areas. It has been noted from the shallows down to 4,000 fathoms. As a fossil it occurs in the Oolite of France, Jurassic of Switzerland, and Post-Tertiary of Norway.

Reophax fusiformis, Williamson.—This is a one-chambered variety of *R. scorpiurus*, and represents uncongenial and shallow-water conditions. It is the commonest species of the foraminiferal fauna in the Hergott section. This is an interesting fact when considered in relation to its known range and distribution. It is not a common form in the present day. It has been taken in the North Atlantic and sparingly off the British coasts. To these localities the Challenger only adds a single one, off the Phillippine Islands, at 95 fathoms, whilst the species has not been previously known to occur in a fossil condition. It was not found in the Hergott material at a greater depth than 200 feet.

Reophax ampullacea, Brady.—This is a flattened variety of *R. difflugiformis*, Brady. Circular at the base, and tapering at the distal end; much compressed. One or two examples which appear to belong to this variety were found in the Hergott material, but it is much rarer than its allied species. The species was founded on Challenger specimens, and these taken at only one station, off Kerguelen Island, in 120 fathoms.

Haplophragmium agglutinans, d'Orb. — This is a coarsely arenaceous crosier-shaped form that can be easily distinguished. It occurs in moderate numbers in the upper portions of the Hergott section. It varies considerably in size, and is built up of very coarse grains of sand. The linear portion is often absent in these specimens from Hergott, probably through being broken off either beforehand or by the attrition caused by the washing. The septal lines are also obscure in these specimens, arising from the very coarse texture of the test; and the rectilineal portion, instead of gradually enlarging towards its extremity, as is generally the case, sometimes tapers to a point. *H. agglutinans* is to be found in all seas at the present day, and although it is sometimes taken in shallow waters, Mr. Brady says it is essentially a deep-sea species, from 500 to over 3,000 fathoms. I have taken it, however, in about two feet of water in the Port Creek. It is known as a Liassic, Lower Tertiary, and Miocene fossil.

Haplophragmium agglutinans, var. *rectum*, Brady. — This variety was named by Mr. H. B. Brady some years ago from a few specimens found in the Lower Carboniferous rocks of Yorkshire. It is a delicate variety, with a very small spiral-line development in comparison with the length of the linear portion. This variety passes into the typical species by every

intermediate gradation, and on this account Mr. Brady has, in his work just published, made *H. rectum* a synonym of *H. agglutinans*. But I think the name may be very well retained as a varietal distinction. In the material now under review they assume very distinct appearances without any intermediate forms that I have observed.

Haplophragmium (?) Canariense, d'Orb.—There are a few small nautiloid examples of *Haplophragmium* in most of the samples from Hergot, but they are in all cases very badly preserved, having been subject to much compression and consequent distortion. In some instances the pressure has been applied laterally, by which the two sides of the shell have been crushed together, and in others the pressure has operated on their peripheral margins, so as to reduce them to an oblong shape. In consequence of such distortion the determination of these minute species is a matter of some difficulty, and has been impossible in the short time and meagre material at my disposal. Some of the best preserved specimens show a resemblance to *H. canariense*, to which I have for the time being relegated them; but it is probable that with better specimens at command it will be found that there are more than one species brought under this determination. Dr. Stache, of Vienna, has figured two species of *Haplophragmium* from the Tertiaries of New Zealand, and it is not unlikely that the examples in Hergott material may possess specific relationship to these. *H. canariense* is of world-wide distribution, although, unlike *H. agglutinans*, it is a characteristic shallow water species. It has not been hitherto known as fossil in rocks earlier than the Pleistocene.

Haplophragmium, sp.—Two examples of what appear to be an undescribed form of this genus were found, one at a depth of about 45 feet and the other at about 200 feet. They consist of a single whorl of large inflated chambers, few in numbers, and in consequence of the large chambers making a sharp turn in the convolution, the septal lines are at very different angles with regard to each other. These await further elucidation.

(*?*) *Nodosinella*, sp.—There are a few straight or slightly curved nodosariform Foraminifera in the material which have been provisionally referred to this genus. The test is rough, apparently finely arenaceous, septation often obscure. None of the examples appear to be in a perfect condition, and their general features seem to indicate a closer relationship to the Carboniferous genus above quoted rather than any other of the Nodosariform group. Nodosinella has not been known hitherto outside of the Carboniferous formation, in which some of its specific forms are widely distributed. Better specimens

may show these Hergott forms to belong to something else, but for the time being we cannot give them a better classification.

(?) *Endothyra Bowmani*, Phillips.—A few examples of a Rotaliform Foraminifer occur at a depth of something under 200 feet that seem undistinguishable from *Endothyra Bowmani*. The *Endothyræ* have been so far only known as a Carboniferous type, and the particular species now referred to may be considered the most characteristic of all the Carboniferous Foraminifera. Its occurrence, therefore, in another geological formation, and one presumably of a much later age, is a point of great interest. In size the examples obtained from Hergott are smaller than the average Carboniferous specimens, but they show a close morphological resemblance to the Palæozoic forms. The same is true of the structure of the test, which in the *Endothyræ* generally is a very fine sub-arenaceous investment. From examination of the Carboniferous specimens Mr. Brady concluded the test to be imperforate, and a careful examination of several transparent sections taken of the Hergott specimens confirms this view, as no perforation of the test walls could be determined. All the examples taken of this interesting species in the Hergott material were obtained by washing down the rough casts of bivalves, already referred to, and indeed the rich gathering of Foraminifera obtained at this depth were all such as had been drifted with the mud into the shells of these molluscs, as they were rendered empty by the death of the shell-fish. Whether these shells afforded the necessary protection against pressure or not I cannot say, but the Foraminifera obtained from their casts were free from that distortion which is so common in the rest of the section.*

Bigenerina.—This is a dimorphous Foraminifer, being Textularian in its earlier growth and Nodosarian in the later chambers. It is one of the most characteristic and interesting of the Hergott forms. The genus is present in the material in two species, *B. nodosaria* and *B. digitata*. The examples might rather, in most cases, be considered as intermediate to these two forms. For the most part *B. nodosaria* approaches *B. digitata* in a more uniform outline, with a

*I have since sent all my mounts of this form, together with the transparent sections, to Mr. H. B. Brady, for his opinion regarding them, and in a letter bearing date of October 15th, 1885, he states :—"Had I found them in beds of Carboniferous age I should certainly have assigned them, as you have done, to *Endothyra Bowmani*, and this under most circumstances should be final. Nevertheless, I cannot speak with positiveness. The surface of the test appears to me granular and corroded rather than really arenaceous. On the other hand I cannot obtain any satisfactory evidence of perforation. Provisionally I should be inclined to assign them to *Endothyra Bowmani*, with some reservation in favour of *Planorbulina* (*Anomalina*) *ammonoides*, or one of the allied Secondary forms."

blunter and more obtuse point than is usual in typical examples; whilst, on the other hand, *B. digitata*, in the Hergott material, is often of the same colour as *B. nodosaria*, and approaches more nearly that species in outline.*

The genus *Bigenerina* is a very ancient one, if Mr. Brady's Carboniferous species, *B. patula*, belongs to this genus. Dr. Dawson has also figured what appears to be the same species from the Laurentian of Canada, and is there associated with the much-disputed *Eozoon Canadense*. The genus is not met with in the Secondary rocks, and the two species to which the Hergott examples are referred make their first appearance, so far as hitherto known, *B. nodosaria* in the Miocene of Vienna and Malta, and *B. digitata* in the later Tertiaries of Italy. The distribution of these species in existing seas is somewhat restricted. *B. nodosaria* is common in the North Atlantic, where it occupies shallow water; it is much rarer in the Mediterranean and North Pacific, but in the southern hemisphere Mr. Brady describes it as "exceedingly rare," being only found at one point in the South Atlantic. *B. digitata* is only known as a European form. The examples in the Hergott beds would imply that these species have had a much wider range in geological times than exists at the present day. Two examples, unfortunately broken, of a much coarser and more robust species of *Bigenerina* were found in one sample of material from Hergott, but these are too imperfect specimens to be dealt with at present.

Gaudryina pupoides, d'Orb.—The genus *Gaudryina* comprehends another dimorphous form of the Foraminifera, in which the earlier chambers follow a triserial arrangement and then pass in their later growth into a biserial order. Its geological history begins with the Cretaceous period, and it is found in most later formations to the present day. The examples from Hergott belong to two species. The most characteristic and plentiful of these species, we have referred to *G. pupoides*, as it possesses in common with that species large and inflated chambers towards the oral extremity, whilst it tapers rapidly towards the primordial end, is finely arenaceous in texture, and possesses a projecting terminal orifice similar to *G. siphonella*. These examples are all more or less flattened, which renders determination the more difficult, but they can very well be classed with *G. pupoides* until better specimens are found to disprove this relationship. In existing seas this species is common in deep water, and occurs in the Challenger gatherings from all parts of the world. It is known as far

* I have more recently obtained very characteristic examples of *B. digitata* from the Tarkaninna Bore, which is in the same geological formation.

back as the Gault, and is most common as a Cretaceous fossil. A single example of this genus was found at a depth of forty-five feet which is both longer and more tapering than those just described, but whether this is simply an individual departure from the typical form or is a member of another species cannot be determined on the evidence of a single example.

Gaudryina (?) scabra, Brady.—This is one of the new species which Mr. Brady has figured from the Challenger dredgings. It has an elongated tapering test, the oral end being broad and rounded, with the opposite extremity obtusely pointed. The triserial portion of the shell forms but a very small proportion of the whole. The aperture is an arched fissure at the inner margin of the last segment. It is rather coarsely arenaceous, and of a brownish colour. This species was taken at only two of the Challenger's stations, and these near together, off Sombrero and Culebra Islands, at depths of 450 fathoms and 390 fathoms respectively. It occurs both in the upper and lower portions of the Hergott section. It apparently agrees closely with Mr. Brady's figures and description of the species, even to the brown colour of the test, of which it shows some trace; but as the examples taken are very limited in number, I have chosen to refer this species as above with some reservation.

Verneuilina polystropha, Reuss.—This is a triserial Foraminifer, with very distinct globose chambers, and is coarsely arenaceous. It is a shallow-water species, seldom being found at a greater depth than 50 fathoms, and has its habitat on muddy bottoms and in estuaries. It is most common in the North Atlantic and Mediterranean, but it has also been found on the coast of Ceylon and on the east coast of Australia. In geological formations it is only known as a Post-Tertiary Foraminifer. Only one example was obtained from the Hergott material, at a depth of 200 feet., but this was perfectly characteristic of the species.

Placopsilina cenomana, d'Orb.—This is a very simple, tubular, and parasitic Foraminifer, often spiralline in the earlier portion, and soon becoming very irregular in growth. It is a parasitic form, and is often found growing on the surface of shells, corals, &c. It is not a very common form at the present day. It is recorded from one of the stations dredged by the Porcupine in the North Atlantic. It is also known as a Mediterranean species, and the Challenger record gives the additional localities of the South Atlantic and the coral reefs of the Pacific. Its home appears to be in the shallow waters of the tropical seas. Two or three examples which may be referred to this species were found in the Hergott material, but all these are from one horizon—and this the lowest of the section

—at 306 feet depth. As it is an adherent form, the absence of objects from the fine silt of the upper portions of the section, which are necessary for the preservation of this form, may account for its absence in the higher horizons. The examples found are attached to fragments of shell or small flakes of shale, but in none of these is the spiralline form apparent. Its geological history dates from the Lower Lias of France ; it is also found in the Lias of France and England, and the Lower Oolite and Cretaceous rocks of Europe, but has not been found in any of the Tertiaries.

Lingulina carinata, d'Orb.—The genus *Lingulina* represents simply a compressed and straight *Nodosaria*. The genus is scarce in the seas of the present day, except in the tropical and subtropical portions of the Atlantic. It is known to exist as far back as the Lias, but it appears to have been always a form possessing but a limited distribution. *L. carinata* is the only species of the genus that occurs in the Hergott section, and but two examples were found. They agree with the figures usually given of this species, but one of the examples obtained has a peculiar inflation of the last segment, which is both larger and rounder than the earlier chambers, and approaches very closely to the Nodosarian character.

Cristellaria rotulata, Lamk.—Two or three fragments apparently belonging to this species have been found at Hergott. No perfect examples have been procured, but by comparing the much-weathered fragments one with another it seems moderately certain that the above is the species to which they belong. This is perhaps the most widely distributed of all the Foraminifera, both as to geographical limits and bathymetrical range, as well as geological time. It is recorded as belonging to almost all geological formations from the Upper Trias of Derbyshire downwards.

Cristellaria gibba, d'Orb.—This is a variation of *C. rotulata* in the direction of *C. crepidula*. That is, the oral extremity is drawn out so as to give an oblong shape to the shell, which is compressed. There are often found a complete series of forms from the almost circular *C. rotulata* to the extremely drawn out *C. crepidula*, with every shade of intermediate modification. D'Orbigny's *C. gibba* stands for the intermediate stage when the crepidulate tendency has been arrested. Its distribution is confounded with allied varieties. Mr. Brady notes its occurrence in North Atlantic and South Pacific at less than 500 fathoms. Its geological range has hitherto dated from the Cretaceous downwards. The examples in the bore material are few, but characteristic.

Marginulina glabra, d'Orb.—This genus unites the Cristellarian and Nodosarian features, with a marginal aperture ; and

on account of being slightly compressed has an oval transverse section. *M. glabra* has a wide range as to depth in the present seas, and is very generally distributed. It is as old as the Upper Lias, and frequently occurs in geological formations of a later date. It is rare in the Hergott material, and none of the examples are perfect.

Pulvinulina elegans, d'Orb.—There is but a single example of this pretty little shell recorded from Hergott. It is small in size, and does not show such a strongly-made test as the species often carries, and is probably a young example. The species is common in the North Atlantic and South Pacific, and also occurs in the Mediterranean. Its geological range dates as far back as the Trias, and it is also known as a Liassic and Tertiary form. It thrives best at moderate depths, from the littoral zone down to 700 fathoms.

Subsequent to the reading of this paper Mr. G. Goyder, jun., sent me a few micro. mounts selected from material taken from about 200 feet depth in this boring, and from which I have been able to determine the three following species as additions to those described above :—

Nodosaria radicula, Linné.—This species is the most typical of the *Nodosarinæ*, has a wide distribution at the present day, is common to both shallow and deep water, and is a common fossil in many microzoic rocks, from the Permian downwards.

Polymorphina lactea, Walker and Jacob.—Common in most seas at present day, but especially the shallows of temperate waters. It is not known much further south than the Cape of Good Hope, and is fossil in Kimmeridge Clay and later.

Vaginulina legumen, Linné.—A pod-like, slightly curved, compressed Nodosarian, widely distributed in present times, and dating from Trias.

General Considerations.

The section is remarkable for the uniformity of its stratigraphical features. With the exception of a few feet at the surface and a few feet at the base of the section, it is practically but one bed extending through a depth of 300 feet. In its fresh condition it would have appeared as a bed of dark mud. The homogeneous character of the sedimentary matter, through so great a depth, implies that the physical conditions which prevailed during its deposition were of a very regular and persistent kind. Not only stones, but sand also, may be said to be absent from this great silt bed, as the grains of quartz visible in most of the washings were so few as to be almost inappreciable. It must have been a landlocked sea or

estuary where the deposit occurred, with still water, and yet exposed to a feeble current that brought a light sediment from no very distant land, which settled down to the bottom within its quiet area. Small crystals are widely distributed throughout the mass, and a few thin beds of limestone were passed through by the drill, that show a dark colour, with spar veins running through the mass tinged with green. The limestone is calcareous, open in texture, and highly crystalline. The Hergott section rests on Primary rocks, and the last nine feet in the bore is evidently a littoral deposit giving indications of a shore line, containing pebbles of quartzite, rounded fragments of chloritic and other schists, which tell the tale of wave action on the shore as the land began to sink beneath the waters.

The section is pretty evenly fossiliferous, but the horizon at which the large bivalve casts occur, at about two hundred feet, has yielded the greatest number of forms, whilst the last nine feet at the base of the section have given the fewest. The palæontological features are restricted in range and belong almost entirely to one group of organisms. About twenty-five species of Foraminifera have been observed, and of these something like seventeen, or nearly three-fourths of the whole number, belong to the arenaceous type. This is a very unusual proportion, as the Foraminifera with calcareous and hyaline tests generally far outnumber those of an arenaceous investment. Of the well-marked species in the list only one can be considered a deep-water species; ten have their habitat in shallow water, and ten are common to both. From this analysis we may safely conclude that the sea in which these Foraminifera lived was of no great depth. It is not so easy to determine their geological age. One and perhaps four species date from Palæozoic times, thirteen are known as Secondary forms, two begin their geological history in the Tertiaries, and five have not been known previously in the fossil condition. The Foraminifera generally, as an order, are of little value in determining geological synchronism. They yield the oldest of all known existing species, and are at one and the same time the most variable and the most persistent of zoological types. The palæontological evidence outside of the Rhizopodal fauna is equally indeterminate of the age of these beds. The large bivalves, so far as I have seen them, are mere casts with a chalky coating, and the two genera that are capable of determination, viz., *Lingula* and *Dentalium*, are both common geological genera dating from early Palæozoic times. The example obtained of the former was microscopic, and of the latter broken into small fragments so as to preclude specific identification. The beds in question have been variously referred to the Jurassic and the Cretaceous periods. They are

undoubtedly Mesozoic, but there is nothing in the microzoa detailed above that throws any light upon their exact geological age.

TABLE showing occurrences and depth of the FORAMINIFERA obtained from the Hergott Bore, their bathymetrical range at the present day, and their geological age as hitherto known.

Family.	Genera and Species.	Depth from Surface in ft.										S. Shallow Water D. Deep Water C. Comm. to both	P. Palæozoic M. Mesozoic T. Tertiary R. Recent
		15	20-40	40-50	50-55	100-200	Bivalves	200	100-300	304-306	306-309		
ASTRORHIZIDÆ—													
Sub. Fam. *Rhabdammininæ*	Hyperammina vagans, *Br.*				x					x		C	M(?)P
LITUOLIDÆ—													
Sub. Fam. *Lituolinæ*	Reophax fusiformis, *Will.*	x	x	x	x	x						S	R
" "	" ampullacea, *Br.*	x			x							S	R
" "	" scorpiurus, *Montf.*		x		x	x						C	M
" "	Haplophragmium agglutinans, *d'Orb.*	x	x	x	x							C	M
" "	" " *var.* rectum, *Br.*	x	x		x	x			x			C	P
" "	" (?) canariense, *d'Orb.*		x	x	x	x		x	x	x		S	R
" "	" species			x		x						S	
" "	Placopsilina cenomana, *d'Orb.*										x	S	M
" *Trochammininæ*	(?) Thurammina papillata, *Br.*	?			x							D	M
" *Endothyrinæ*	(?) Nodosinella sp.	x				x							P
" "	(?) Endothyra Bowmani, *Phil.*					x							P
TEXTULARIDÆ—													
Sub. Fam. *Textularinæ*	Bigenerina nodosaria, *d'Orb.*	x		x		x						S	T
" "	" digitata, *d'Orb.*	x			x	x						S	T
" "	Gaudryina pupoides, *d'Orb.*	x	x	x	x							D	M
" "	" (?) scabra, *Br.*			x		x				x	x	C	R
" "	Verneuilina polystropha, *Reuss*					x						S	R
LAGENIDÆ—													
Sub. Fam. *Nodosarinæ*	Nodosaria radicula, *Linné*							x				C	P
" "	Lingulina carinata, *d'Orb.*		x			x						S	M
" "	Cristellaria rotulata, *Lamk.*							x				C	M
" "	" gibba, *d'Orb.*				x	x						S	M
" "	Marginulina glabra, *d'Orb.*							x	x			C	M
" "	Vaginulina legumen, *Linné*							x				C	M
" *Polymorphininæ*	Polymorphina lactea, *W. and J.*							x				S	M
ROTALIDÆ—													
Sub. Fam. *Rotalinæ*	Pulvinulina elegans, *d'Orb.*	x										C	M

Supplemental Notes on the Palliobranchs of the Older Tertiary of Australia, and a Description of a New Species of Rhynchonella.

By Professor Ralph Tate, F.G.S., F.L.S., &c.

[Read October 6, 1885.]

The following notes are addenda to my paper on "The Palliobranchs of the Older Tertiary of Australia," published in these transactions for the year 1880:—

I. New Species.

Rhynchonella Baileyana, *Tate*. Plate vi., figs. 3*a*—3*c*.

Ref.—Southern Science Record, January, 1885, p. 1.

Shell transversely ovate-trigonal, sub-depressed; dorsal valve regularly convex from the umbo to the middle, thence flattish to the front of the mesial fold, which is broad and not very prominent; the ventral valve is less convex, with a broad sinus of moderate depth commencing at half the distance from the beak and extending to the front. The anterior-fourth of each valve is plaited and circumscribed by a conspicuous fold of growth; there are seven plaits on the mesial fold and about four on each lateral area. The mesial fold occupies about one-third of the front of the shell, rising abruptly from the lateral areas. The beak is very small, moderately produced, with a minute circular foramen under its angular and slightly-incurved extremity which is surrounded and separated from the hinge line by a deltidium of two pieces.

Length, 25; breadth, 18; thickness, 12 millimetres.

The species is dedicated to the memory of Mr. John F. Bailey, late of Melbourne, to whose enthusiasm for science he recently fell a martyr, by whom it was collected at Jemmy's Point, at the entrance to the Gippsland Lakes.

Rhynchonella Baileyana is an interesting addition to the palliobranch fauna of the Australian Tertiary period, inasmuch as it differs so widely from living and Tertiary species, and recalls some Mesozoic ones. I do not know of any other fossil which has so depressed and broadly oval form conjoined with marginal plications and a small sub-erect beak as it possesses

II. Species still Living.

Rhynchonella squamosa, *Hutton*.

This species in a living state was taken off south of Kerguelen Island during the Challenger expedition, and has been redescribed by Mr. Davidson in Brachiopoda of the Challenger Exped., t. 4, f. 14, p. 59 (1880), as *R. nigricans*, var. *pixydata*.

III. Additions to the Provincial Lists of Species and Localities.

Victoria.—Terebratula vitreoides, *T. Woods.* Muddy Creek. J. Dennant!
Waldheimia Garibaldiana, *Davidson.* Corio Bay!
insolita, *Tate.* Corio Bay! Muddy Creek, near Hamilton, and Limestone Creek, near Ascot, Glenelg River. J. Dennant!
grandis, *T. Woods.* Limestone Creek, J. Dennant!
Terebratulina Scoulari, *Tate.* Balcombe and Corio Bays!
lenticularis, *Tate.* Corio Bay!
Magasella compta, *Sowerby.* Mordialloc, J. F. Bailey! Muddy Creek, J. Dennant!
Rhynchonella Baileyana, *Tate.* S. Gippsland, J. F. Bailey!

Tasmania.—Extracted from paper by Mr. R. M. Johnston in Proc. Roy. Soc. Tasm. for 1884, p. 223:—

Waldheimia furcata, *Tate.*
Johnstoniana, *Tate.*
grandis, *T. Woods* (*!*)
Corioensis, *McCoy.*
pectoralis (?), *Tate.*
Terebratulina Scoulari (?), *Tate.*
lenticularis, *Tate.*
triangularis, *Tate* (*!*)
Terebratella Tepperi, *Tate.*

South Australia.—From the clayey sands with green grains pierced by the bore sunk at the Waterworks Yard, Adelaide:—

Terebratula vitreoides, *T. Woods.*
Waldheimia insolita, *Tate.*
Terebratulina Scoulari, *Tate.*
lenticularis, *Tate.*
Terebratella furculifera, *Tate.*

IV. Species Common to the Older Tertiary of Australia and New Zealand.

Magasella Woodsiana, *Tate.* (*Waldheimia tapirina*, Hutton.)
Terebratula Aldingæ, *Tate.*
Terebratella furculifera, *Tate.*
Waldheimia insolita, *Tate.*
Terebratulina Scoulari, *Tate.* (*Waldheimia Suessii*, Hutton.)
Rhynchonella squamosa, *Hutton.*

The first identification is on the authority of Prof. F. W. Hutton, by whom it has been communicated to me *in litteris;* the others are based upon comparisons of actual specimens made by myself.

The Lamellibranchs of the Older Tertiary of Australia. (Part I.)

By Professor Ralph Tate, F.G.S., F.L.S., &c.

[Read October 6, 1885.]

Plates II.—XII.

FAMILY OSTREIDÆ.

Genus Ostrea.

SYNOPSIS OF SPECIES.

I. Valves radially ribbed, spinose.	*O. hyotis.*
II. Valves foliated or smooth—	
Elongate; beaks produced	*O. Sturtiana.*
Oblong; beaks subspiral.	*O. arenicola*
Broadly attached, with erect front; beaks depressed.	*O. hippopus.*

Subgenus Gryphæa.

Umbo of lower valve largely incurved.	*G. tarda.*

Ostrea hyotis, Linn. Plate vi., fig. 5.

Ref.—Reeve, Monogr. Ostrea, t. 4, fig. 7.

"Shell irregularly subquadrate, solid, armed with tube-shaped spines standing out upon the angles of about seven large folds; auricles rather compressed foliaceous plicated."—*Reeve.*

I refer a very common oyster in the Middle Murravian series, with some hesitation, to the above-named species inhabiting the Indian Ocean; the fossil, however, rarely exhibits tubular spines, more generally broad foliaceous scales; in shape it varies from subquadrate to semicircular and obliquely oblong; the plications usually angular, are sometimes rounded when it approaches to *O. imbricata*, Lamk. In the absence of examples of the fore-named living species, I refrain from separating our fossil.

Dr. K. Martin has figured, under Linnæus' name, an oyster from the Older Tertiary of Java,* a variety of which is oblong. According to this author, the same species occurs in the Indian Tertiary beds, whence it has been described as *O. tubifera*, Sowerby in Trans. Geol. Soc., v., tab. 25, fig. 19., 1837.

Localities.—Calciferous sand rock, River Murray-cliffs at

* Die Tertiarshichten auf Java, p. 125, t. 21, figs. 1 and 2, 1880.

Maunum, Blanchetown, Morgan, &c., very common ; mouth of the Onkaparinga River, St. Vincent Gulf, one example (*R.T.*).

Ostrea Sturtiana, *spec. nov.* Plate vi., fig. 1.

Shell narrowly oblong to subtrigonal, test very thick, margins not denticulated; upper valve nearly flat, ornamented with depressed lamellæ, margin included in the lower valve, which is attached by a small part of the umbonal area or apparently free. Lower valve moderately deep, externally radially wrinkled and scaly lamellose; hinge of lower valve narrow, elongated, deeply and broadly channelled in the middle; hinge of upper valve shorter and broader. Muscular impression very large, somewhat reniform.

Dimensions.—Height, 85; breadth, 53; thickness through both valves, 40 millimetres.

Among recent species it approaches some varieties of *O. edulis*, but on account of its ponderosity, dissimilar ornament of the valves, and the large hinge, it may usefully have a specific designation applied to it. And I associate with it the name of Captain Sturt, who refers to this species under the name of *O. elongata*, Deshayes (*O. cucullaris*, Lamk.).

Locality.—This species constitutes banks up to ten feet or more in thickness in the upper part of the River Murray-cliffs from Overland Corner to beyond Blanchetown.

Ostrea arenicola, *spec. nov.* Plate x., fig. 6.

Shell roundly-oblong, somewhat produced anteriorly, rather compressed, solid, valves not very unequal; umbos depressed, slightly bent forwards. Lower valve moderately convex, attached by a small part of the umbonal area or free; marked with many roundly depressed radial ribs and foliaceous lamellæ. Upper valve flattish or sharply convex, smaller than and included within the lower valve, marked with flattened imbricating lamellæ.

Dimensions.—Height, 80; breadth, 85; thickness through both valves 25 millimetres.

The nearest ally is the southern analogue of *O. edulis*—the Port Lincoln oyster, *O. Angasi*—from which it differs in the depressed and forward-directing umbos, in the greater width at the front, and more decidedly costated; by the same characters it is separated from *O. Sturtiana*.

This species is usually found in the sand-beds alternating with the hard calciferous sandstones which form the topmost of the fossiliferous strata at Adelaide and in the cliffs at Aldinga Bay. It has seemingly been the habit of the species to attach themselves to one another or to be free.

Examples attached by a moderately large surface resemble

O. corrugata, Hutton, but the single specimen of that species which I possess is too imperfect for critical comparison.

An extreme variety occurs in the Upper Murravian at the North-West Bend, attached to *Meleagrina* by whole surface, except a narrow erect expansion which is externally laminated and occasionally plicatedly wrinkled; the upper valve is smooth and has the pointed recurved umbo so characteristic of the Aldinga specimens.

A thin-shelled form, having much resemblance to the last variety, which was obtained from the Adelaide bore may for the present be associated therewith.

Localities.—Upper Aldinga series at Aldinga and Adelaide.

Var. *a.*—Upper Murravian, North-West Bend, on the River Murray.

Var. *b.*—Lower Aldinga series at Adelaide. A minute valve having a thick test showing irregular structure from Schnapper Point, Hobson's Bay.

Ostreahippopus, *spec. nov.* Plate iv., figs. 1*a*—1*b*.

Shell suborbicular, inequivalve; hinge-line straight, umbo depressed, sub-central. Upper valve nearly flat, undulose towards the margin, which is included within the lower valve; surface with irregularly concentric lamellæ. Lower valve attached by a very large surface with an erect margin, which is externally faintly wrinkled and striate longitudinally, and lamellose concentrically.

Dimensions.—Length, 66; height, 60; depth of elevated front, 40 millimetres.

Locality.—Glauconitic limestone, Aldinga Bay.

Subgenus Gryphæa.

Gryphæa tarda, Hutton. Plate vi., figs. 2*a*—2*b*.

Ref.—Hutton in Cat. Tert. Foss. of New Zealand, p. 35, 1873.

Shell rather thin, oblong or irregularly rotund.

Inferior valve tumid very convex, smooth, with broadish folds of growth; free or sessile by a small umbonal area; anterior-ventral margin produced into a conspicuous lobe; umbo subacute, incurved and bent forward; ligamental area broad, moderately excavated medially; muscular impression oblong, situated towards the margin on the produced side. Superior valve flat with an elevated margin, ornamented with imbricating lamellæ.

Dimensions.—Inferior valve, height, 45; breadth, 32; thickness, 23 millimetres.

Localities.—Glauconitic limestones and polyzoal rock, north side of Blanche Point, Aldinga Bay; chalk rock of the Bunda

Cliffs, Great Australian Bight, South Australia (*R. Tate*). Chatham Islands, New Zealand (*Hutton*).

Observations.—Our fossil cannot be mistaken for the recent *G. angulata*, Lamarck, but it bears a close resemblance to the Cretaceous *G. vesicularis*, Lamarck, from which it differs in its more triangular outline, larger lobation, and in the superior valve being lamellose. In my description of the chalk-rock of the cliffs of the Great Australian Bight I have remarked that, "on a cursory inspection one is struck by its similarity to the chalk of England, heightened by the presence of layers of black flints and of fossils with a Cretaceous facies such as *Salenia* (*S. tertiaria*, Tate), *Cidaris* (*C. australasiæ*, Duncan), *Gryphæa* (*G. tarda*, Hutton), like *G. vesicularis*, a *Terebratula* (*T. subcarnea*, Tate) barely distinguishable from *T. carnea*, *Terebratulina*, &c." Trans. Roy. Soc., S. Aust., 1879.

Hitherto *G. tarda* has been found at the Australian localities only in the lowest beds of the marine series of the Older Tertiary. I am not sure if our fossil is correctly named, as I have not had specimens of the New Zealand species for comparison, it answers fairly well to Hutton's diagnosis, except that it is only of about half the size. The original description reads as follows:—Irregularly ovate, umbo of left valve incurved and bent slightly forwards; exterior smooth, with concentric striæ; right valve rather concave, often thickened near the margin, much smaller than the left valve; area broad triangular, distinctly transversely striated; muscular impression suborbicular, rather flattened above where it is deeply sunken, posterior, placed high up; height 2·4, length 1·7 inches.

Genus Dimya, *Rouault.*

The genus *Dimya* was founded for an oyster-like fossil of the Parisian Eocene with a second adductor impression, and by most conchological writers has been placed in the family Ostreidæ, the additional scar being regarded as the homologue of the small anterior scar in *Pecten*. Tyron* seems to have studied a living example of the genus dredged off the Antilles, which he describes as "essentially an oyster having two adductor muscles, the exterior layer of the shell pearly, the inner porcellanous, hinge with a pit like *Hinnites*." He follows Stolickza (in "Cretaceous Pelecypoda of Southern India") in placing the genus in the sub-family Vulsellinæ, family *Aviculidæ*. As the anatomy of *Dimya* agrees with that of *Ostrea*, the original position assigned to the genus in the scheme of classification would thus appear to be the correct one, despite the fact of its dimyarian character.

* Systematic Conchology, vol. iii., p. 281, 1884.

The two new species which I refer to *Dimya* have the general aspect of *Plicatula* rather than of *Ostrea;* whilst the two diverging cardinal ridges make an approach to *Placuna*, though functionally different. The internal characters presented by them are as follows:—

Right valve attached, with two diverging cardinal ridges crenulated for the greater portion of their length; cartilage pit triangular, with a raised margin, within the angle formed by the cardinal ridges. Posterior muscular impression large, oval, in about the same position as the single scar in *Plicatula;* the anterior scar is ovate, small but deeply impressed, close under the end of the cardinal ridge; pallial line entire. Left valve free, with two diverging cardinal furrows crenulated within the grooves.

SYNOPSIS OF SPECIES.

Coarsely radially ribbed; internally ribbed.	*D. sigillata*.
Finely radially ribbed; margin only ribbed.	*D. dissimilis*.

Dimya dissimilis, *spec. nov.* Pl. iii., figs. 9*a*—9*c*.

Shell ovate-oblong to ovate-triangular; inequivalve, inequilateral, posteriorly oblique; umbo sub-central, dorsal line usually straight. Right valve attached by varying extent of surface; free part obliquely elevated, slightly convex, ornamented by many high-rounded ribs frequently bifurcating towards the front, crossed by lamellæ which give rise to imbricating scales or spinous scales on the radial ribs. Left valve free, flattish, a little swollen in the umbonal region, depressed centrally, and elevated at the margin; scaly fringed with imbricating lamellæ. Interior of both valves with radial riblets interposed between the pallial line and the shell margin, most conspicuous in the dorsal region.

Dimensions.—Length, 10; height, 13 millimetres.

Localities.—South Australia: Gastropod-bed, near Morgan, and elsewhere in the Middle Murravian, in the raggy limestones at Mannum, on the River Murray; Salem, near Callington, on the R. Bremer; Rolls Point, Nepean Bay, Kangaroo Island. Victoria: Muddy Creek, Hamilton, and Corio Bay, Geelong (*R.T.*)

Dimya sigillata, *spec. nov.* Plate viii., figs. 8*a*—8*b*.

Shell ovate-oblong, inequivalve, subinequilateral, posteriorly somewhat oblique; umbos subcentral, dorsal line usually straight.

Right valve attached by a large surface, free part much elevated, ornamented by numerous rounded radial riblets and a few imbricating lamellæ of growth. Left valve free, slightly concave, except in the umbonal region, included within the

right valve; faintly rayed and concentrically laminated. Interior of both valves with conspicuous radial riblets within the pallial line and terminating there; the denticulations of the cardinal ridges continuing on the lateral margins and gradually developing into riblets.

Dimensions.—Length, 65; height, 7·5 millimetres.

Localities. — Turritella clays and glauconite limestones, Aldinga; glauconite sands, Adelaide bore; chalk-rock, Bunda Cliffs of the Great Bight.

D. sigillata differs from *D. dissimilis* in the erect front of the attached valve and finer ornament, and by the radial riblets within the pallial line; in the last particular this species recalls certain *Plicatulæ* of the Cretaceous and Jurassic rocks of Europe. *D. sigillata* approaches externally rather to *Ostrea* than to *Plicatula*, whilst the converse is true of its congener, *D. dissimilis*.

FAMILY ANOMIIDÆ.

Anomia cymbula, *spec. nov.* Plate ix., fig. 5.

Shell obliquely oblong-ovate, somewhat solid, convex, with compressed sides; umbo subcentral, acute, perceptibly elevated, submarginal; surface densely rayed with slender riblets, which are covered with subspinous transverse scales.

Dimensions.—Height, 10; length, 5; depth of valve, 3·5 (nearly) millimetres.

Locality.—Turritella-clays at Blanche Point, Aldinga Bay.

Genus Placunanomia.

SYNOPSIS OF SPECIES.

Valves ornamented with coarse radial threads, subspinose. *P. Ione.*

Valves ornamented with fine radial threads. *P. sella.*

Placunanomia Ione, *Gray.* Pl. v., figs. 7*a*—7*b*.

References.—Proceedings Zoological Society, 1849, p. 123; Hutton, in Cat. Marine Moll. of N.Z., 1873, p. 84.

Superior or left valve irregularly orbicular, usually slightly convex, but varying from flat to very convex, horny-pellucid, surface ornamented with imbricating scaly lamellæ and radial threads or ridges; umbo sub-marginal, depressed, with a slight back curvature. Ligamental scar within the umbonal cavity transverse oblong, circumscribed by a raised border, radially striated, adjacent to the anterior margin of which is a small conspicuous pedal scar.

Dimensions.—Length, 54; height, 47 millimetres.

Localities.—Oyster banks of the Upper Murravian at the North-West Bend, and of the Upper Aldinga series at Aldinga

and Adelaide. Muddy Creek, Hamilton, a few small flat smooth examples (*J. Dennant*).

It is not with confidence that I refer the fossil under review to the recent species inhabiting the waters of the New Zealand and South Australian shores. It exhibits, however, very great variation, especially in respect to the radial ornamentation. Usually the rays are obsolete, except towards the margin. In other examples the rays are moderately strong and numerous, as in recent examples, but occasionally the ribs are thickened, elevated, and raised into sub-spiny scales, the ribs being generally few in number.

Though the attached valve is unknown, despite the fact that several score of the free valves have been collected, yet there cannot be a doubt that it is correctly placed in the genus *Placunanomia*, as the shelly base of the plugs are conspicuous objects on oysters and other molluscous shells associated in the same deposit.

Placunanomia sella, *spec. nov.* Pl. v., figs. 1*a*—1*c*.

Shell suborbicular to triangular-ovate, thin, inequivalve, inequilateral; umbos depressed, marginal. Left valve convex from the ventral to the dorsal margin, with lateral areas more or less elevated; right valve concave, with depressed sides, sinus small pyriform. Surface of both valves ornamented with numerous radial threads and lamellæ of growth. In young shells the radii are minutely scabrous; a variable character consists of radial and concentric undulations. Interior of left valve with a submarginal oblique cartilage pit and two oval subcentral muscular impressions; the latter are superimposed, that produced by the muscle of the plug the larger. Interior of right valve with a single adductor impression within the posterior margin of the disc, posterior lobe of notch overlapping on the anterior lobe, and more or less agglutinated therewith; the margin of the notch with a raised border. In adult specimens the marginal border is excessively developed to form a tubular sheath, to which the shelly base of the plug becomes adherent.

Dimensions of a largish specimen.—Length, 43; height, 40 millimetres.

Localities.—South Australia: Abundant in the basal part of the calciferous sandstone of the River Murray cliffs at MacBean's Pound, near Blanchetown; in a well-sinking, "Nine-Mile Camp," near the North-West Bend (*R.T.*)

Tasmania: Table Cape, determined from a left valve received from Mr. R. M. Johnston.

Victoria: A thin, translucent form, with flattish sides, is common at Muddy Creek; a very small example, Schnapper Point, Hobson's Bay (*R.T.*)

New Zealand: Two left valves of an unnamed "Ostrea, No. 175, from Oamaru Creek, Otago," received from the Wellington Museum, are comparable with the triangular-ovate form of *P. sella*. The two subcentral muscular scars so characteristic of the genus are well displayed.

FAMILY PECTINIDÆ.

Genus Pecten.

SYNOPSIS OF SPECIES.

I. Radially ornamented.
  1. Inequivalve, interspaces with shagreen-sculpture.
    Eight radial folds and many riblets. *P. consobrinus.*
    Twelve truncated ribs. *P. subbifrons.*
    Seven broad plications or compressed plicæ. *P. palmipes.*
  2. Inequivalve; no shagreen-sculpture.
    Ribs simple. *P. Murrayanus.*
    Ribs dichotomously divided. *P. dichotomalis.*
  3. Equivalve; radial ribs more or less scaly.
    Ribs 25, flatly rounded, one or two riblets on each flank. *P. antiaustralis.*
    Ribs 25, rounded, broader than interspaces, densely squamose. *P. Eyrei.*
    Ribs 35-40, flatly rounded. *P. Flindersi.*
    Ribs 35-40, acute; one riblet on each flank. *P. Peroni.*
    Ribs 30, flatly rounded equal to the furrows. *P. Sturtianus.*
    Ribs 50, narrow; oblique-linear sculpture in the interspaces. *P. Aldingensis.*
    Ribs 60-70, very narrow. *P. Yahlensis.*
  4. Radially plicate and ribbed with spinose ornament.
    Flat; plicæ 9, intermediate ribs 9. *P. Foulcheri.*
    Inflated; plicæ 7-9, intermediate ribs 7-9. *P. spondyloides.*
  5. Radially plicate and ribbed with scaly ornament.
    Radial folds 7-9, simple. *P. Gambierensis.*
    Radial folds bifurcating; corrugated. *P. polymorphoides*

II. Valves smooth, or nearly so.
  Surface concentrically striated; ears plain. *P. Hochstetteri.*
  Surface faintly rayed; ears rayed. *P. Yahlensis.*

III. Valves with *internal ribs.*
  Valves smooth or concentrically striated, internal ribs 30-36 pairs. *P. lucens.*
  Valves concentrically or reticulatedly striated or ribbed; internal ribs 9. *P. Zitteli.*

Pecten consobrinus, *spec. nov.* Plate iii., fig. 6.

Shell orbicular, fan-shaped, slightly convex, equilateral, subinequivalve, the left valve somewhat flatter. Ornamented with about eight radial folds and numerous (about 100) thickish riblets; the riblets are rigid, unequal in size, and separated by irregular intervals which are minutely granular and usually broader than the riblets.

Right valve with rayed, unequal ears; anterior ear larger, subaliiform, slightly notched on the underside; posterior ear triangular, perpendicularly truncated. Ears of left valve unequal, radially ribbed; the anterior one larger, triangular, outer margin curved; posterior ear triangular, perpendicularly truncated.

Dimensions.—Length and height about 85 millimetres.

Localities.—Oyster banks of the Upper Aldinga series at Aldinga and Hallett's Cove, St. Vincent Gulf.

It is with some hesitation that I separate these shells from *P. bifrons*, but the slight differential characters relied on are observable at all stages of growth; thus left valves of 15 millimetres diameter are distinguished by their three-ridged radial ribs; at 30 millimetres diameter, whilst *P. bifrons* has yet the elevated simple scaly ribs and plain furrows, *P. consobrinus* has almost lost the plicæ which are replaced by four or five threads, and about three occupy the furrows; these divergencies culminate in the very numerous radial threads and obsolete folds of the adult. Similar changes are observable in the other valve. *P. consobrinus* is moreover less inequivalve than *P. bifrons*.

Pecten subbifrons. Tate. Plate iii., fig. 2.

Ref.—Proc. Roy. Soc. S. Australia, vol. iv., p. 44. 1882.

Shell orbicular or triangularly orbicular, fan-shaped, equilateral, slightly inequivalve, umbos depressed.

Right valve slightly convex, rayed with twelve compressed truncated ribs about equalling in width to the deep flatly concave furrows; the ribs carry two or three irregularly granular nodose riblets, and there may be one or two raised lines in the furrows. The surface, save on the riblets, granular-shagreen. Ears rayed, unequal; the interior one much larger, outwardly curved and sinuated below; posterior triangular. Left valve rather flatter than the right, but with similar ornament; ears subequal, obtuse-angled, rayed. Interior of both valves plicated but not ribbed.

Dimensions.—Length and height, 50 millimetres; a smaller specimen, length 28, height 30 millimetres.

Localities.—Oyster beds, Government house quarry, Adelaide *(R.T.)*, Polyzoal-bed, mouth of R. Onkaparinga.

This species, which has the general form and shagreen-sculpture of *P. bifrons*, differs from it chiefly by its compressed truncated and more numerous ribs; the valves are flatter and the ears, particularly of the right valve, differ somewhat.

Pecten palmipes, *spec. nov.* Plate v., fig. 4. Plate vii., figs. 4*a*—4*b*.

Shell triangularly orbicular, inequilateral by projection of posterior part; slightly inequivalve, the right valve a little more convex than the left; ears large subequal, umbos depressed. *Right valve* rayed with seven broad rounded plications, gradually becoming broader and flatter as they approach the margin; the interstitial spaces are narrow and deep. The whole surface rayed with numerous linear ridges, the interspaces minutely granulated. Posterior ear triangular, obliquely truncated, rayed; anterior ear, larger, projecting, outer margin curved, indented on the under side, radially ridged. *Left valve* more depressed in the umbonal region, rayed with six compressed elevated plicæ, the flatly rounded surfaces of which are bordered by two furrows, increasing in number towards the front; the interstitial spaces between the plicæ are very broad and deeply concave, bearing riblets in old shells towards the margin. Spaces between the riblets minutely granulated. Ears triangular obliquely or perpendicularly truncated, radially ridged, subequal, the anterior one larger.

Dimensions of largest specimen.—Length 71, height 71, thickness through both valves 27 millimetres.

Localities.—Edithburgh, Yorke Peninsula; oyster banks, Aldinga Bay.

This species has the general characters of the recent South Australian *P. bifrons*, of Lamarck, possessing also its peculiar granular shagreen-sculpture; but it differs by the obliquity of its valves, in being higher than long, and in the form of its radial plicæ; the interior is plicated but not ribbed as in the living species.

Pecten Murrayanus, *spec. nov.* Plate vii., figs. 5*a*—5*b*.

Shell orbicular, fan-shaped, somewhat thin, scarcely equilateral, projecting slightly in front, inequivalve; valves rayed with about 20 rounded ribs broader or equal in breadth to the concave furrows, the whole crossed by close-set, thin, erect lamellæ coincident with the margin; the lamellæ increase in denseness from the umbo forward. Interior with flat ribs corresponding with the exterior furrows.

Left valve slightly and regularly convex; umbo acute, not extended beyond hinge line. Ears unequal, the anterior large roundly truncate, finely striated, perpendicularly and faintly rayed; the posterior elongate, arcuate, prominently rayed and concentrically striated.

Right valve nearly flat, depressed at the umbo; ears equal truncate, finely striated perpendicularly, faintly rayed.

Dimensions.—Length, 47; height, 45; thickness through both valves, 10 millimetres.

Localities.—Common in the calciferous sandstone of the Middle Murravian, Blanchetown, &c.; rare in the Lower Murravian at Mannum. Not uncommon at Muddy Creek, Hamilton.

This species belongs to a small group represented by *P. solaris*, Born, but it is not identical with any of the living species monographed by Reeve. *P. solarium*, Lamk., a fossil species of the European Tertiary, is also of the same type, but *P. Murrayanus* is distinguished by its fewer ribs and smaller wings.

P. leopardus, Reeve, is its nearest ally, but the ribs are fewer, separated by wide interspaces, and is scarcely equivalve.

Pecten dichotomalis, *spec. nov.* Plate ix., figs 3*a*—3*c*.

Shell suborbicular, fan-shaped, thin, equilateral, inequivalve, umbos depressed. Right valve regularly slightly convex, with about nine broad radial undulose folds, whole surface ornamented with flat riblets narrower than the interspaces which are crossed by raised threads about half the width of the alternating grooves. The riblets increase in number to more than 100 by two successive bifurcations at irregular intervals, and towards the margin are covered with minute imbricating scales; front margin undulate and minutely crenulated. Ears unequal, dorsal line distantly serrately fringed; anterior ear slightly sinuated on the underside, with five to six radial ridges covered with small triangular serratures; posterior ear triangular, slightly obtuse-angled, with seven to eight serrated ridges. Left valve flat, with the radial folds angular, the riblets stouter and less numerous, the anterior one-fourth of the surface densely covered with conspicuously large, erect scales. Ears large, equal; radial ridges about three on which are a few scattered, erect, triangular scales.

Dimensions.—Length, 32; height, 30; thickness through both valves, 4·5 millimetres.

Locality.—Schnapper Point, Hobson's Bay (*R. T.*).

Pecten antiaustralis, *spec. nov.* Pl. ix., figs. 7*a*—7*c*.

Synonym.—P. asperrimus, var. *Tate.* Trans. Roy. Soc., S. Aust., vol. iv., p. 34, 1882.

Shell sub-orbicular, moderately convex sub-equivalve, the right valve less convex, sub-æquilateral, rayed with about 25 ribs which are flanked by one or two smaller ribs on each; the ribs and riblets are convex, crossed by erect lamellæ, the

interstitial furrows flattish, arcuately striated. Ears unequal large, radially ridged and transversely lamellate-scaly; right-posterior, triangular, obliquely truncated, anterior produced, sinuated ventrally; left-posterior similar to corresponding one in right valve, anterior larger, obtuse angled.

Dimensions of a large individual.—Length and height, 58; thickness through both valves, 25 millimetres.

Localities. — Oyster beds in the uppermost strata at Adelaide, Hallett's Cove, and Aldinga Bay; Edithburg and Stansbury, Yorke Peninsula (*R.T.*).

This species is very closely allied to *P. australis*, Sow., which is probably identical with *P. asperrimus*, Lamarck, but as my comparisons have been made with what is certainly the former, my remarks have reference only to it. The chief differences observable are the *lamelliform* ornamentation of the convex ribs and riblets, whilst in *P. australis* they are angular, and beset with distant scaly serratures or spinous scales; moreover the valves, especially the left valve, is more convex.

The young of the two species are much alike, having simple ribs, developing with age a riblet on each side. Rarely does *P. australis* acquire more, but *P. antiaustralis* does so as a rule, and aged examples exhibit two or three on each flank, and often one in the furrow, whilst the concentric lamellæ are continuous across the furrows.

The ears of the fossil species are larger, and the shell attains to greater dimensions.

P. antiaustralis, however, exhibits variations in the degree of convexity of the valves and ribs, whilst *P. australis*—the commonest shell on the S. Australian coast—is true to its type; nevertheless, it is easy to separate the species.

P. actinoides, Sowerby, of the Chilian Tertiary, is apparently a near ally.

Pecten Eyrei, *spec. nov.* Pl. viii., figs. 3*a*—3*b*, 6.

Shell ovate orbicular, scarcely equilateral, sub-inequivalve, slightly convex, ornamented with about 25 rounded ribs as broad or broader than the smooth interspaces; ribs with close-set erect crescentric scales; occasionally a riblet is interposed between the primary ribs towards the front. Ears unequal, radially ridged, and transversely lamellated; of the right valve, the posterior ear triangular, obliquely truncate; anterior ear elongated with a deep byssal sinus; of the left valve, the anterior larger than the posterior with the outer margin curved, the anterior one perpendicularly truncated.

Dimensions.—Length, 45; height, 48; thickness through both valves, 12.

Localities.—Chalk rock of the Bunda Cliffs, Great Australian Bight; Polyzoal rock, Aldinga Bay; at mouth of the River Onkaparinga; and at Surveyor's Point, Yorke Peninsula (*R.T.*).

The species may appropriately be named in honour of Sir John Eyre, from the circumstance of its occurrence at Wilson Bluff, Great Australian Bight, whose graphic description of an attempt to scale this bold headland must be familiar to those who have read the narrative of his adventurous overland journey to Perth.

Pecten Flindersi, *spec. nov.* Plate viii., fig. 7.

Shell obovate to triangular, orbicular, equilateral, or slightly inequilateral, equivalve moderately convex, umbos depressed, acute, ornamented with from 35 to 40 flatly rounded ribs with broader interspaces. The ribs are smooth or surmounted by distant minute scales; the interspaces are marked with perpendicular engraved lines.

Ears as in *P. Eyrei.*

Dimensions.—Millimetres.

Length.	Height.	Thickness.	No. ribs.
54	56	23	35
51	54	—	40
43	50	—	30
35	37	11	37
77	80	38	40
60	—	15	50

Localities.—Glauconite limestone, Aldinga Bay; glauconite sands, Adelaide bore; clays at Muloowurtie, Yorke Peninsula.

P. Flindersi has a general resemblance to *P. rudis*, G. B. Sowerby in Darwin's Geol. Observ., of the Chilian Tertiary, but that shell has fewer ribs with narrower interspaces.

Species-name in commemoration of Captain Flinders, the intrepid Australian navigator.

Pecten Peroni, *spec. nov.* Plate x., figs. 1*a*—1*b*.

Shell ovate-orbicular, equilateral, equivalve, nearly flat, umbos acute, depressed, ornamented with numerous acute or subacute scaly ribs flanked on each side by a scaly riblet; interspaces very shallow, a little wider than the ribs, minutely granular. The primary ribs vary from about 35 to 40, and with the riblets are covered by crescentic scales or short triangular spines. Ears as in *P. Eyrei*, but the posterior ones with the dorsal margin usually serrately fringed.

Dimensions.—Length, 39; height, 42; thickness through both valves, 11 millimetres.

Localities.—Polyzoal limestone, Aldinga Bay; Adelaide bore.

This species is more depressed, equilateral, and has more ribs than *P. antiaustralis* and *P. australis*, whilst the anterior ear of the left valve is not winged.

This species is dedicated to the memory of M. Peron, the naturalist to the Baudin Expedition, as a mark of my appreciation of his geological observations on Kangaroo Island.

Remarks on the affinities of the three foregoing species :—

They agree in one particular, which distinguishes them from *P. australis* and *P. antiaustralis*, namely, that the anterior ear of the left valve is not winged.

The oldest species in time is *P. Flindersi*, which is depressed, and ornamented with numerous, narrow, rounded ribs, smooth or distantly scaly; in *P. Eyrei* the ribs are fewer in number, broad, and densely scaly; whilst *P. Peroni*, which occupies an intermediate geological position, has the numerous narrow, but acute ribs of the former, and the dense scaly ornament of the latter, diverging, however to the spinous scales of *P. australis*.

Pecten Sturtianus, *spec. nov.* Plate vii., figs. 2*a*—2*c*.

Shell nearly orbicular, convex, equivalve, equilateral; about 30 flatly rounded radial ribs covered with distant, thick, imbricating scales, the alternating furrows about as broad as the ribs, marked with transverse or oblique lines. Margin of valves crenulate-undulate. Right valve with unequal ears; the posterior larger, triangular, and subaliiform, strongly rayed and granular or spinosely scaly; the anterior ear triangular, faintly three-rayed, with perpendicular lamellæ conspicuous only towards dorsal margins, and obliquely striated, Left valve, posterior ear elongately produced, narrow, deeply excavated by a byssal sinus, four nodular-scaly ribs; anterior small, similarly ornamented to corresponding ear in the right valve.

Dimensions. — Length, 18; height, 18·5; and thickness through both valves, 10 millimetres.

Localities.—Not uncommon in the Calciferous sandstones of the R. Murray cliffs at Blanchetown, &c.; raggy limestones at Mannum (*R. T.*); rare Muddy Creek, Hamilton.

The species is dedicated to the memory of Captain Sturt, the pioneer geologist of the basin of the Lower Murray river.

P. Sturtianus has a general resemblance to *P. Malvinæ*, of the Viennese Miocene.

Pecten Aldingensis, *spec. nov.* Pl. vii., figs. 1*a*—1*c*.

Shell orbicular, or a little longer than high, thin, subequilateral, inequilateral. Right valve moderately convex, left valve flatter, ears unequal; both valves ornamented with

about 50 narrow, rounded, sub-depressed ribs, straight or slightly flexuous, with narrower interspaces, which are sculptured with oblique linear sulci and punctures; towards the front margin a few indistinct concentric lamellæ cross the ribs.

Right valve with the ears very unequal, the anterior aliiform, radially and concentrically scaly-striated, ventral margin sinuated for the passage of a byssus; posterior ear triangular, vertically and radially scaly-striated.

Left valve with unequal ears, the posterior one the smaller; both triangular, and radially costated and scaly.

Dimensions.—Length and height, 32 millimetres.

Locality.—Glauconitic limestone, Aldinga Bay.

Pecten Yahlensis, *Tenison-Woods.*

References.—Phil. Soc., Adelaide, 1865, t. 1, fig. 4; *P. Yahlensis*, var. *semilævis*, McCoy, Prodr. Pal. of Victoria, Decade iv., t. 34.

Shell sub-orbicular, thin, equilateral; valves unequal, and with dissimilar sculpture.

Right valve deeper than the left, moderately convex, polished; surface radiated with numerous (60-70) sub-equal, nearly straight, narrow, flatly-rounded ridges, separated by shallow concavities, rather less than the width of the ridges, crossed by distant concentric lines of growth. Ears, with the posterior one a little larger than the anterior; both slightly obtuse-angled, radially ridged, and marked with concentric lines of growth, which rise on the dorsal margin as projecting angular scales; anterior ear slightly sinuated anteriorly for passage of byssus.

Left valve nearly flat, surface radiated with nearly straight, narrow, rounded ridges, about one-third of their width apart, crossed by sharp, erect, crowded, concentric lamellæ. Ears about equal, slightly obtuse-angled, radially ridged, crossed by concentric lamellæ, which form a serrated fringe on the dorsal margin.

In the *var. sublævis* the right valve is quite smooth, whilst another variety has the rostral portion smooth, and the marginal portion radiately ridged.

Dimensions of average sized specimens.—Length and height, about 55 millimetres; but specimens are known from four to five inches in diameter.

Localities.—South Australia: Mount Gambier limestone (*Tenison-Woods*); raggy limestones at Mannum, R. Murray (*R.T.*)

Victoria: Muddy Creek (*R.T.*); Mordialloc; Corio Bay; Bairnsdale; Schnapper Point, Hobson's Bay; near mouth of Sherbrook River (*McCoy*).

"This fossil resembles the well-known German Miocene Tertiary species, the *Pecten Hofmanni* of Goldfuss, so nearly that at first sight one might mistake one for the other; the ridges, however, are slightly larger, usually more nearly equal and less rigid in this species, which is totally distinguished by having the right or deeper valve different from the other, while they are both alike in the *P. Hofmanni*" (*McCoy, op. cit.*).

Pecten Foulcheri, Tenison Woods.

Pecten sp., Sturt. Two Exped., &c., tab. 3., fig. 14.

Pecten sp., Tenison Woods, Geol. Observ., p. 74 (1862).

P. Foulcheri, Tenison Woods, Proc. Phil. Soc. Adelaide, 1865, tab. 1, fig. 3.

Shell thin, equivalve, inequilateral by projection of the front; valves flatly convex with about nine radial angular plicæ on which are scattered towards the front spinous imbrications passing to squamose imbrications on the umbonal region, the concave furrows and sides of plicæ with about nine raised lines, squamosely imbricate especially towards the umbo, the whole crossed by fine concentric striæ.

Ears very unequal; the left anterior moderately large triangular ornamented with three to four rays, squamosely imbricated towards proximal end, and concentric striæ. Left posterior large aliiform with a deep byssal sinus, ornamented with five or six squamosely-imbricate rays. Right anterior as left anterior. Right posterior much larger, subaliiform with several scaly rays.

Dimensions of an averaged specimen.—Length 33, thickness 34, thicknes through both valves millimetres. A large specimen measures 41 by 43 millimetres.

Localities.—Somewhat common in the Mount Gambier limestone *(Tenison Woods)*; very abundant in the Calciferous sandstone of the River Murray Cliffs (*R. Tate*); Table Cape, Tasmania *(R. M. Johnston!)*; rare Muddy Creek.

Tenison Woods' illustration of this species is a good representation of the common form, around which may be grouped several varieties; whilst individual variations have been developed to such extremes that it would be justifiable to establish three or four species out of them if the connecting variations were awanting.

In the typical form the spinous-processes on the plicæ are slender and distant, occasional examples show crowded large imbricating squamæ and the ornament on the interstitial ridges equally gross. Again the plicæ are broad and convex; in others the flanking ridges to the plicæ acquire the magnitude of the central ridge, this state is usually accompanied by almost obliteration of the furrows and the substitution of scales for spines.

The plicæ only are usually continued as smooth angular ridges on the umbonal portion, the whole surface of which is delicately shagreen-sculptured. In some examples the shagreen-markings cover the whole shell, whilst in others the plicæ and raised lines maintain their scaly ornament to the umbo.

Pecten spondyloides, *Tate*. Pl. iv., figs. 6 and 7.

Reference.—Proc. Roy. Soc., S. Australia, vol. iv., p. 44, 1882.

Shell equivalve, equilateral, about as long as high, inflated, covered with numerous spiniferous ribs. There are usually seven or nine primary ribs, two or three secondaries, and a variable number of tertiaries between each pair of primary ribs, all similarly ornamented. Front margin of valves curved, slightly crenulated, not at all angular. Ears equal, of moderate size, triangular, outer margin perpendicular; there is no byssal sinus.

Variety.—Pl. IV., fig. 7. With the prickly scales of the interstitial ribs reduced to spine-like serratures, and the spines on the primary ribs slender and distant; regular concentric striæ mark the whole surface.

Dimensions of the figured specimen.—Length and height, 44; thickness through both valves, 34 millimetres. A large perfect specimen measures 90 mills. in diameter, whilst fragments indicate a greater magnitude.

Localities.—Oyster banks of the Upper Aldinga series at Aldinga Bay, Hallett's Cove, and Adelaide. The *variety* in the raggy limestones at Mannum.

This very handsome shell has much the appearance of a *Spondylus*, hence its trivial name, and more particularly of *S. imperialis*, of the Chinese Seas; however, it is a Pecten, having an edentulous hinge; moreover, the regular curved umbos of both valves presented by shells of all ages are characters not belonging to *Spondylus*.

Pecten Gambierensis, *Tenison-Woods*.

Reference.—Proc. Phil. Soc., Adelaide, 1865, pl. i., fig. 2.

Shell thick, inequivalve, the left valve regularly convex, the right flatter; inequilateral by projection of the anterior area, ornamented with from five to seven radial folds, which together with the interspaces are covered with imbricating, granular, close-set ribs, the sulci between the ribs regularly transversely striated. Ears unequal, the anterior one small, truncated; the posterior larger, rounded, and strongly ribbed.

Dimensions.—Length and height, about 30 millimetres.

Localities.—Coralline limestone at Mount Gambier and Mosquito Plains (*T. Woods, R.T.*).

The ornament varies in the closeness and stoutness of the radial ribs and their granulations, whilst the plicæ are some

times almost obsolete. The species differs from *P. polymorphoides* in its fewer ribs, never bifurcating or presenting intercostal ribs towards the front margin, and by the regular convexity of its valves.

Pecten polymorphoides, *Zittel.* Plate viii., fig. 2.

Reference.—Pal. von Neu-Seeland, p. 51, t. xi., fig. 3, 1864.

Synonyms.—*Pecten incertus* (*Tenison-Woods*), Proc. Phil. Soc., Adelaide, 1865, tab. i., fig. 1. *P. coarctatus* (*Sturt*), Two Exped., vol. II., t. iii, f. 13; id. *Ten.-Woods*, in Geol. Obs., p. 74, fig.

Shell triangularly orbicular, inequivalve, very inequilateral, projecting anteriorly; convex, inflexed in front; umbonal part irregularly rudely tumulous, rayed with five to seven rather broad ribs; ribs and sulci longitudinally ridged. The ridges, which are covered with imbricating scales, increase in number by bifurcation towards the front, and are there grouped more or less in pairs; interstices between ridges concave, regularly transversely striated; front edge of valve crenulate-dentate. Ears of left valve very unequal; the anterior one is of moderate size, abruptly truncated, with a few scaly rays; the posterior one is elongated, with four stout, coarsely scaly rays; byssal sinus narrow and deep; adductor scar narrow, placed high up on the anterior area.

Dimensions.—Length, 44; height, 40; thickness through both valves, 16 millimetres.

Localities.—Middle Murravian, near Morgan, Blanchetown, and Mannum; Muddy Creek, Hamilton (*R. T.*). Also in the Oamaru series, New Zealand.

P. polymorphoides exhibits some variability in respect to the development of the radial ridges and the corrugations in the umbonal region, and to the extent of the inflexion of the front. Young specimens are nearly equilateral; Zittel's figure represents the species at an early stage of growth, and in which the radial ridges and the ventral inflexion are pronounced; his description does not well apply to the adult shell in respect to the subsmooth or obsoletely striated plicæ, and the auricles as figured by him are not exact. Tenison-Woods' figure of his *P. incertus* represents an averaged-sized specimen, but without corrugations. A specimen of *P. polymorphoides* of about 25 millimetres, sent to me by Professor Hutton, removes any doubt as to the specific identity of the two shells. *P. Burnetti* (Zittel) is a closely-related species.

Among living congeners, *P. polymorphoides* is related to *P. convexus*, Quoy and Gaimard (*P. roseopunctatus*, Reeve, and *P. vellicatus*, Hutton), but its more numerous scaly and slender ridges and the umbonal corrugations distinguish it; and

according to Zittel it is allied to the Mediterranean *P. polymorphus*, Br., but I have no specimens of that species for comparison.

Sturt has given a very good figure of a small example of this species, identifying it with the European *P. coarctatus*; Tenison-Woods reproduces Sturt's figure on p. 76 of his "Geol. Observations," and in his "Introduction to the Tertiary Rocks of South Australia," Phil. Soc., Adelaide, May, 1865, refers Sturt's shell to *P. Gambierensis*. From this association I dissent, as Sturt's figure well shows the umbonal corrugation and inflexed front so characteristic of *P. incertus*, and moreover *P. Gambierensis* does not occur in the Murray cliffs, whilst *P. incertus* is not a rare shell.

Pecten Hochstetteri, Zittel.

Reference.—P. Hochstetterri, *Zittel*, in Palæontologie von Neu-Seeland, p. 50, t. xi., figs. 5*a* and 5*c* (non 5b), 1864; and *Hutton* in Cat. Tertiary Fossils of New Zealand, p. 30, 1873.

Synonym.—Pecten pleuronectes, *Tenison-Woods*, in Proc. Phil. Soc., Adelaide, 1865, pl. i., fig. 5 (non Gmelin).

Shell nearly orbicular, equivalve, equilateral, thin, compressed; both valves smooth, but when slightly weathered showing fine concentric striæ. Ears of right valve subequal, roundly truncated, transversely striated, the anterior one slightly sinuatedly striated. Ears of left valve equal, obliquely truncated, transversely striated. Interior of valves without ribs.

Dimensions.—Longitudinal diameter 58, transverse diameter 60 millimetres.

Localities.—White coralline limestone at Mount Gambier; raggy limestones at Mannum, River Murray; the glauconite limestone, Aldinga Bay; glauconite clayey sands, Adelaide bore; yellow clayey sands, Moolowurtie, Yorke Peninsula; Oamaru formation of New Zealand from several localities.

Having specimens of *P. Hochstetteri* from New Zealand, I can with certainty announce the fact of this species occurring in the Older Tertiary rocks of South Australia.

Zittel describes the right valve as radially ribbed, which is represented by his fig. 5*b*; but specimens agreeing with his fig. 5*a* have been obtained with the valves in opposition, both of which are smooth. Hutton amends Zittel's diagnosis, excluding fig. 5*b*, which belongs to another species, apparently *P. Yahlensis*, Tenison-Woods.

P. Hochstetteri has an external resemblance to the species of the Pleuronectes group, but it is devoid of internal ribs, and is equivalve. This type is well represented in the European Jurassic rocks, indeed our species very much resembles

P. lunularis, Röm., of the Lias. It is highly probable that Tenison-Woods confounded this species with *P. pleuronectes* in his record of the occurrence of the recent species in the Mount Gambier limestone, as the only smooth pecten known to me to be found there is *P. Hochstetteri.*

Pecten lucens, *spec. nov.*

Shell nearly orbicular, slightly inequivalve, equilateral, a little gaping at each side below the ears, compressed, thin, pellucid, externally smooth but radially and concentrically striated under the lense; internally rayed with from 30 to 36 pairs of ribs. Right valve slightly convex from the umbo to the anterior margin; ears equal, straight, truncated, transversely striated and faintly radially ridged. Left valve depressed in the umbonal region; ears obliquely truncated, transversely striated, upper margin sometimes dentate; hinge area internally thickened, bearing at each anterior corner a subacute boss.

Dimensions.—Transverse and longitudinal diameters 48 millimetres; thickness through both valves 10 millimetres. My largest specimen measures 100 millimetres in the diameters.

Localities.—Oyster bed, Aldinga Bay; calciferous sandstone of the River Murray Cliffs at Blanchetown.

P. lucens differs from all living species of the group by the greater number of the internal radial ridges, and by the same character it is separable from the Chilian fossil species, *P. Darwinianus*, D'Orb., to which it bears a close resemblance.

Pecten Zitteli, *Hutton.* Pl. vii., figs. 3*a*—3*c*.

Reference.—Catalogue Tertiary Mollusca of New Zealand, p. 32, No. 118 (1873).

Synonym.—Pecten sp., *Zittel* in Palæontologie von Neu-Seeland, p. 53, t. 9, figs. 1*b* and 3, 1864.

Amusium Atkinsoni, *R. M. Johnston*, in Proc. Roy. Soc., Tasmania, 1880, p. 41.

Shell small, sub-orbicular, compressed, equilateral, equivalve. Interior of both valves concave, shining, with nine or eleven ribs which terminate truncatedly near the margin. Right valve reticulatedly striated or ridged; left valve concentrically striated; ears unequal. The exterior ornament of the right valve varies very much in respect of the number and thickness of the radial and concentric threads; usually the radial threads are stouter than the raised concentric lines, but this form merges on the one hand into a fenestrated ornament, and on the other to one in which the radial ridges are very prominent and minutely scaly. Ears of right valve unequal, the posterior larger and triangular, cancellate; anterior triangular, with concentric scaly lamellæ.

The left valve is invariably concentrically striated, the interior ribs showing as faint dark lines, but may present a smoothed surface from exfoliation of the external shell layer. Ears very unequal, posterior the larger, aliiform, distantly arcuate-ridged and faintly rayed; anterior triangular, concentrically striated.

Dimensions of a large specimen.—Length, 10; height, 9·5 millimetres.

Localities.—Abundant in the Turritella-marls, Aldinga Bay; glauconitic sands, Adelaide bore; Muddy Creek, Vict.; gastropod bed, R. Murray cliffs.

Table Cape, Tasmania (*R. M. Johnston!*).

Several stations of the Ototara Group, New Zealand (*Hutton, op. cit.*).

Zittel's figures represent the interior with ten ribs; Hutton, however, describes the interior with eleven ribs, and the exterior as smooth. Nevertheless, two impressions of right valves from Waihao River in my possession, received from the Wellington Museum, show distinct traces of a fenestrated ornament between eleven radial lines indicating the internal ribs. I think it is clear that Hutton's diagnosis is based upon an excorticated specimen of a left valve, and that the Waihao River specimens here referred to supply the desiderated characters necessary to establish specific identity between the very perfect Australian specimens and those on which *P. Zitteli* has been founded.

In respect to *P. Atkinsoni*, Johnston, a left valve of which in my possession, kindly communicated by the describer, is in every respect identical with Australian specimens, I am inclined to the opinion that the dissimilar ornament of the right valve has escaped his notice, and I have little hesitation in referring it to *P. Zitteli*.

It is only at Aldinga and Adelaide that are found examples of large dimensions equalling those of the New Zealand ones. The Table Cape and Muddy Creek specimens are usually less than half the size.

P. Zitteli recalls *P. personatus*, Zieten, of the Lower Jurassic rocks of Europe; the Tertiary, *P. pygmæus*, Munster, seems to belong to the same type, which is unrepresented in living creation.

Hinnites Corioensis, *McCoy*.

Ref.—Prodromus Palæontology of Victoria. Decade VI., pl. lviii.; 1879.

Localities.—Victoria—Extremely common at Corio Bay; near Bairnsdale, on the Nicholson River (*McCoy*). South Australia—Glauconitic limestone of Aldinga Bay.

SYNOPSIS OF THE SPECIES OF THE

SUB-FAMILY LIMINÆ.

GENUS LIMA.

Radial ornament simple.	
Obliquely ovate, 25 to 30 ribs.	*L. Bassii.*
Ovate-trigonal, 70 ribs.	*L. polyactina.*
Radical ornament divaricate.	*L. linguliformis.*

SECTION LIMATULA.

Radial ribs prominent.	*L. Jeffreysiana.*
Radial striæ very numerous.	*L. polynema.*

GENUS LIMEA.

Ribs many, obtuse, interspaces cancellated.	*L. transenna.*
Ribs 14, interspaces striated transversely.	*L. alticostata.*

Lima Bassii, *Tenison-Woods.* Plate v., fig. 8; plate viii., fig. 1.

Reference.—Proc. Roy. Soc., Tasmania, for 1876, p. 112 (1877).

Shell obliquely subovate, somewhat compressed, rather solid, rayed with from 25 to 30 imbricately squamose ribs; margin full and equally rounded with a prolonged curve, post-dorsal side short and very slightly concave, almost margined through its whole extent by a small obtuse-angled auricle, which is radiately and squamosely ribbed; anterior side, with an obsolete auricle, truncated with a straight sloping line; lunule rayed with granular ribs. Umbos acute, and only slightly arched. Hinge line narrow, lateral margins of hinge area with a small denticle. The ribs vary much in number, irrespective of size of shell, as few as 21 and as many as 34 have been counted; they are usually flatly rounded with narrower interspaces, but specimens from the River Murray cliffs have subangular ribs; the interspaces are transversely striated or lamellate, or, as in the case of examples from the Lower Aldinga series, obliquely sculptured.

Dimensions of figured specimens.—Pl. 5., fig. 8, dorso-ventral diameter 31·5, lateral diameter 27, thickness through both valves 5 millimetres; pl. 8., fig. 1, the respective values are 30, 26, and 5. Diameters of largest specimen 41 and 33.

Localities.—Type-form with rounded ribs and transverse sculpture between. Table Cape (*R. M. Johnston!*); Muddy Creek (*R.T.*).

Var. a with subangular and transverse lamellæ between. Middle Murravian series near Morgan and Blanchetown (*R.T.*).

Var. b with flatly rounded ribs and oblique sculpture between. Glauconitic limestone, Aldinga Bay; glauconitic sands, Adelaide-bore (*R.T.*).

L. Bassii so closely approximates to *L. squamosa*, or the so-

named species of Australian seas, that it is with some hesitation I venture to separate them. However, *L. Bassii* may be distinguished by its flatter shell, less inflated beaks, less produced anteriorly, and by its narrower hinge line, whilst the ribs are usually more rounded and the anterior ear obsolete.

Taking two examples of about the same size, the following measurements will formulate some of the above-mentioned differences :—

	L. Bassii	*L. squamosa*
Antero-dorsal diameter ...	41	39 millimetres
Lateral diameter	33	35 "
Breadth of hinge... ...	10	13 "

The New Zealand Older Tertiary species, *L. multiradiata* and *L. paleata*, Hutton, are closely related to *L. Bassii*, but in them the ribs are wider apart.

Lima polyactina, *spec. nov.* Pl. viii., figs. 4*a*—4*c*.

Shell minute, ovate-trigonal, ventricose, nearly equilateral; lateral and ventral margins regularly convex, attenuated towards the dorsal line, ornamented with numerous (about 70) depressed radial ribs, smooth or minutely-scaly, interstices narrower than the ribs, punctatedly impressed. Hinge line very short, almost wholly anterior; umbos erect, acute, divergent; lunule-area deeply impressed; anterior auricle minute, triangular, posterior obsolete.

Dimensions.—Ventro-dorsal diameter, 4; lateral diameter, 6 millimetres.

Locality.—Adelaide bore, three examples (*R.T.*).

Lima linguliformis, *spec. nov.* Pl. iii., figs. 1*a*—1*b*.

Shell oval, sub-compressed, equivalve, almost equilateral; valves gaping in front, ornamented with flattened, slightly wavy, inconspicuous ribs which radiate from the longitudinal centre-line; ribs obscurely granose-nodulose towards the ventral margin, the narrow interstitial furrows coarsely punctated. Anterior auricle, with the outer margin thickened and everted; posterior auricle obsolete.

Dimensions.—Ventro-dorsal diameter, 19; lateral diameter, 15; thickness through both valves, 6 millimetres.

Locality.—Muddy Creek (*R.T.*); Schnapper Point, Port Phillip Bay (*R.T.*).

This fossil species is allied to *L. scabra*, Born., and *L. tenera*, Chem., by its divaricate sculpture, and approaches the latter in shape, but differs in its oval outline and imperfect posterior auricle.

Lima Jeffreysiana, *Tate.* Pl. iv., fig. 8.

Reference.—Proc. Roy. Soc., Tasmania, for 1884, p. 230.

Synonym.—*Lima subauriculata*, Tenison-Woods, Proc. Roy. Soc., Tasm., for 1876, p. 113 (1877), (*non Montfort*).

Shell thin, elongate-ovate, with nearly straight sides, subequilateral by the slight obliquity of the hinge line, ventricose. Surface ornamented with distant, acute, longitudinal ribs and close-set, undulate, concentric striæ; the rays are very conspicuous on the middle and anterior parts, but become indistinct towards the posterior border; the intercrossing of the medial ribs and the concentric striæ form blunt imbricating serratures; the concentric striæ merge into strong folds towards the anterior border. Auricles of moderate size, equal, sharply angular. Umbos elevately and acutely produced.

Dimensions.—Length, 23; breadth, 15; thickness, 16 mills.

Localities.—Table Cape (*R. M. Johnston!*); Yorke Peninsula, Aldinga, River Murray Cliffs, Mount Gambier; Muddy Creek and Schnapper Point, Hobson's Bay (*R. Tate*).

L. subauriculata and *L. elliptica* differ from *L. Jeffreysiana* by their ribs, smooth sides, medial furrows, and more inflated umbos. Among recent Australian shells the fossil species approaches *L. Strangei*, from which it differs by its straighter sides, by its more numerous and acute ribs, and by being more ventricose.

Species dedicated to Mr. Gwyn Jeffreys, F.R.S., the eminent conchologist, in acknowledgment of his help in its elaboration.

Lima polynema, *spec. nov.* Plate x., fig. 9.

Shell thin, ventricose, obliquely ovate; surface marked with very fine, numerous (about 90) radial threads and a few distant concentric striæ.

Dimensions. — Ventro-dorsal diameter, about 10; lateral diameter, about 7 millimetres.

Locality.—Glauconitic sands, Adelaide bore.

An imperfect specimen only known, but is distinguishable among recent and Tertiary species by its numerous simple radial threads and nearly straight sides.

Limea transenna, *spec. nov.* Plate ix., figs. 6*a*—6*b*.

Syn.—? *Cucullæa minuta*, Johnston, Proc. Roy. Soc., Tasmania, for 1879, p. 40 (1880).

Shell small, thin, obliquely subtrigonal; ventricose, attenuated in the dorsal region, expanded towards the ventral margin, which is posteriorly obliquely produced. Umbos elevately acutely produced. Valves closed, rayed with numerous obtuse ribs, the interstitial spaces broader, granulated in the middle line, and cancellated by equidistant concentric striæ

interrupted by the radii. Auricles small, angular; hinge line narrow, with four or five longitudinal plications on each margin. Inner margin of valves crenulated.

Dimensions.—Ventro-dorsal diameter, 8·5; lateral diameter, 6; thickness through both valves, 5.

Localities.—Muddy Creek, Hamilton; Mount Gambier, white polyzoal limestone (*R. T.*). Probably this species at Table Cape, Tasmania.

In this species the denticulations of the hinge are longitudinal and marginal; whilst in *L. alticosta* they are transverse, and occupy the whole length of the hinge-line.

Mr. R. M. Johnston has described a shell under the name of *Cucullæa minuta*, op. cit., which from its description may be either *Limea transenna*, or conspecific therewith. He moreover states that it is not unlike *Limatula subauriculata* [*L. Jeffreysiana*] in general appearance. I transcribe its diagnosis:—"Shell very minute, thin, obliquely oval; hinge-line straight, narrow, with three or four teeth, oblique at extreme corners; surface of valves ornamented with fine radial ridges, and crossed by lines of growth; towards the margin the ridges are lamellar, and are also imbricated where intersected by the concentric lines of growth; margin finely crenulate; long. 3 mil., lat. 2½ mil., thickness at umbo of both valves 1½ mil. Rare, Table Cape."

Limea alticosta, *spec. nov.* Plate iii., fig. 8.

Shell minute, shortly oval, slightly inequilateral, dorsal line short, straight; umbo central, elevated, obtusely produced; auricles small, unequal. Rayed with 14 elevated subacute ribs, narrower than the interspaces, faintly striated transversely. Hinge margin with from six to seven transverse denticles on each side of the ligamental socket. Ventral margin strongly crenate.

Dimensions.—Length and height exceeding two millimetres.

Locality.—Adelaide bore (one ex.).

This species resembles the type of the genus, *L. Sarsii*, but is more inequilateral and has plain ribs; its similarity to *L. acuticosta*, Munster, of the European Lias is very striking, from which it differs externally by its less oblique shape, whilst the hinge teeth of that species are longitudinal on the outer margins, and not transverse throughout the cardinal line.

FAMILY SPONDYLIIDÆ.

Genus Spondylus.

SYNOPSIS OF SPECIES.

Finely ribbed between the primary ribs.	*S. pseudoradula.*
Coarsely ribbed between the primary ribs.	*S. gæderopoides.*

Spondylus pseudoradula, McCoy.

Reference.—Prodromus Pal. Victoria, Decade v., pl. 45, fig. 2 (1877).

Localities.—Victoria: clays near Mount Martha in Port Phillip Bay; claybeds of Muddy Creek; at Fyansford, Bairnsdale, and Mordialloc (*McCoy*).

South Australia: common in the calciferous sandstones of the River Murray Cliffs (*R.T.*).

Spondylus gæderopoides, McCoy.

Reference.—Prodromus Pal. Victoria, Decade iv., pl. 38 (1876); Dec. v., pl. 45, figs. 1 and 3.

Localities.—Victoria: sandy strata of Bird Rock Bluff, near Geelong; in the cream-colored limestone of Boggy Creek, six miles from Sale, Gippsland (*McCoy*).

South Australia: glauconitic limestone and Turritella limestone bands at Blanche Point, Aldinga Bay; in the glauconitic clayey sands, Adelaide bore; in the chalk rock of the Bunda Cliffs, Great Australian Bight (*R.T.*).

FAMILY AVICULIDÆ.

Avicula nasuta, *spec. nov.* Pl. xi., fig. 11; pl. xii., fig. 12.

The aviculid represented on pl. xi., fig. 11, is the best of the few specimens that have come under my observation; it is not only imperfect, but has lost its external shell layer, and a complete diagnosis of the characters is not possible. The figured specimen is a right valve, incorrectly shown as a left valve. However, a fragment illustrated by fig. 12, pl. xii., is complete so far as regards the umbo and anterior wing, the disproportionate length of the latter part in conjunction with the shape of the valve seem to afford specific characters.

Dimensions.—Length, about 40; width, about 20 millimetres.

Locality.—Adelaide bore, in brown clayey sand with glauconitic grains.

Meleagrina crassicardia, *spec. nov.* Pl. ix., figs. 9 and 10.

Shell slightly oblique, roundly quadrate, inequivalve, very inequilateral, left valve moderately tumid, right valve flatter. Hinge-line long, straight, with a distinct cardinal tooth in the young shell; the ligamental area very broad, and flattened externally, cardinal tooth obsolete in the adult. Anterior auricle of the left valve short, tumid, and acutely pointed, that of the right valve depressed, slightly emarginated below at the narrow byssal fissure; posterior wing small but distinctly developed, acutely pointed. The surface shows indistinct, distant striæ of growth, but to the unaided eye appears smooth.

Dimensions.—Young example, pl. ix., fig. 9. Length of hinge, 37; greatest length measured from umbo to the post-ventral margin, 37 millimetres. Average-sized adult specimens measure about 60 millimetres in the transverse diameters.

Localities.—Muddy Creek, Hamilton (young examples only); oyster-beds, North-west Bend Head Station, near Morgan, on the River Murray (adult examples only). *R. T.*

Vulsella lævigata, *spec. nov.* Plate iii., figs. 3*a*—3*b*.

Right valve narrow oblong, attenuated dorsally and rounded ventrally, posterior side nearly straight, anterior side somewhat arched; greatest width in the dorsal-third; umbo a little swollen and elevated, not divergent from the hinge. Surface irregularly concentrically lamellose, especially in the umbonal region. Hinge-line short; but the ligamental socket proportionately long, triangular, erect.

Dimensions.—Length 11, height 29 millimetres.

Locality.—Glauconitic limestone at the base of Witton Bluff, near mouth of the River Onkaparinga.

By the absence of crenulated striæ or scales, and by its form, it approximates to *V. deperdita* of the European Eocene, but that shell is broader with diverging umbos; its resemblance to *V. angustata*, Deshayes, of the Parisian Eocene is very close, from which the present species differs by the large, straight, ligamental pit.

Perna, *sp. ind.*

Locality.—Witton Bluff, at the mouth of the River Onkaparinga. A cast of a large species apparently identical with an undescribed species from the "Trelissick Group," New Zealand.

SUB-FAMILY PINNIINÆ.

Genus Pinna.

Valves convex, longitudinal ribs with erect scales.
P. semicostata.

Valves acutely angulated, longitudinal ribs without scales.
P. sp.

Pinna semicostata, *spec. nov.* Plate xii., fig. 9.

Triangular, elongate, slightly sinuated at the byssal region; valves very convex with abrupt sides, the dorsal half with rather close obsolete longitudinal ribs (about ten) raised into close short semi-cyclindrical scales; the ventral half with strong concentric folds.

Dimensions.—Length of dorsal margin 130, width 65, greatest thickness through both valves 43 millimetres.

Localities.—Oyster banks, Adelaide and Aldinga Bay.

This species has a general resemblance to *P. Zealandica*, Gray, from which it differs by the longitudinal scaly ribs being confined to the dorsal surface, and by its much greater convexity.

Pinna, *sp. indet.*

Apical portions only known. Valves acutely angulated, with faint longitudinal ribs separated by broad interspaces on the ventral slope, crossed by undulose ridges.

Calciferous sandrock, River Murray cliffs, near Morgan.

FAMILY MYTILIDÆ.

Genus Modiola.

Shell ovate-oblong, inflated.	*M Adelaidensis.*
Shell elongated, inflated.	*M. sp.*
Shell elongated, compressed.	*M. sp.*

Modiola Adelaidensis, *spec. nov.* Pl. xi., fig. 3.

Ovate-oblong, with inflated subterminal beaks, the anterior end very narrow and obtuse; the post-dorsal portion is dilated and becomes gradually flattened, the ventral side is comparatively narrow and convex. Posterior margin broadly subrotund, dorsal margin slightly curved, ventral margin straight, anterior margin rounded, projecting beyond the umbo. Surface with well-defined concentric folds of growth.

Dimensions.—Greatest length, 28; greatest width at right angles to longitudinal diameter, 18; greatest thickness through both valves, 13 millimetres.

Locality.—Glauconitic sands, Adelaide bore.

This fossil species has some resemblance to certain individual varieties of the recent *M. flavida*, but is distinguished by the larger and less anterior umbones.

Modiola, *sp. indet.*

Similar to the last, but longer and narrower; the single specimen known is unfortunately somewhat crushed.

Length, 43; breadth, 17 millimetres.

Locality.— Glauconite sands, Adelaide bore.

Modiola, *sp. indet.*

A compressed elongate shell, with nearly terminal beaks, is indicated by casts in the calciferous rocks on the River Murray, and at Salem, near Callington, on the River Bremer.

Length, 55; breadth, 20; thickness through both valves, 13 millimetres.

Lithodomus, *sp. indet.*

Casts and crypts of a *Lithodomus* in the coral *Plesiastræa Vincenti* occurring at Hallett's Cove indicate a short tumid shell with broad incurved beaks, the anterior end slightly convex, the posterior obliquely obtuse.

Length, 21; breadth, 10; thickness through both valves, 11 millimetres.

Genus Mytilus.

Shell cylindrical tumid.	*M. sp.*
Shell subquadrangular.	*M. subMenkeanus.*

Mytilus, *sp. indet.*

An imperfect specimen of a cylindrical tumid mussel, finely longitudinally striated on the steep ventral slope, has been obtained from the glauconitic limestone at Blanche Point, Aldinga Bay. Length 47, width 15 millimetres.

Mytilus subMenkeanus, *spec nov.*

A complete diagnosis is impossible from the fragmentary state of the specimens, which, however, indicate a species of the general form of the recent *M. Menkeanus*, but with fewer and stouter longitudinal ribs.

Locality.—Hallet's Cove, on the horizon of the oyster banks at Aldinga Bay.

Septifer fenestratus, *spec. nov.* Pl. ix., fig. 1.

Shell elongate-triangular, very inequilateral, equivalve; umbos almost marginal, subacute, curved; anterior side nearly straight, slightly outwardly convex about the middle, rising abruptly to the elevated rounded umbonal ridge; dorsal line straight; post-dorsal area depressed, its margin making an obtuse angle (about 120°) with the dorsal line; ventral margin attenuated, rounded; byssal sinus inconspicuous. Surface ornamented with numerous divaricate subacute ribs, the interspaces shallow, concave, broader than the radial ribs, latticed by stoutish raised lines; also by distant imbricating folds of growth. Hinge thickened anteriorily with a small umbonal shelf (umbonal cavity is filled up at the senile stage of growth); ligamental groove linear, slightly obliquely extending posteriorly; the whole inner margin of the valves crenulated, the crenulations on the hinge line becoming denticulate, and three or four beneath the umbo are much larger than the rest.

Dimensions—Length of hinge-line, 9·5; antero-dorsal to post-ventral margins, 16; thickness through both valves, 8 millimetres. An unusually large specimen has the first two dimensions respectively 28 and 44 millimetres.

Localities.—Muddy Creek; Corio Bay; Schnapper Point, Hobson's Bay, Victoria (*R. T.*).

This Australian fossil *Septifer* proves to be distinct from its congeners. So far as I have been able to make comparisons, it approaches *S. denticulatus*, Lamk., but differs in its high rounded umbonal ridge and its latticed ornament.

GENUS MODIOLARIA.

SYNOPSIS OF SPECIES.

Shell obliquely ovate-oblong. *M. singularis.*
Shell oblong, very inflated, acutely truncated behind. *M. arcacea.*
Shell oblong, moderately inflated, roundly truncated.
Depressed anterior area without rays. *M. semigranosa.*
Depressed anterior area with twelve acute ribs. *M. Corioensis.*

Modiolaria singularis, *spec. nov.* Pl. iii., fig. 7.

Shell obliquely ovate-oblong, equivalve, inequilateral, thin, translucent; umbos large, obtuse, approximate, a little anterior. Surface finely concentrically striated; umbonal ridge obscurely radially lined. Hinge line crenulated, rest of inner margin plain, except post-ventrally, where it is thickened and crenulated, the crenulations corresponding with the radial lines, which are more conspicuous internally than externally.

Dimensions.—Length, 2·5; height, 3; thickness through both valves, 3 millimetres.

Locality.—Muddy Creek, a single perfect shell (*R. T.*).

Though the form approximates to *Crenella*, yet as the hinge characters are proper to *Modiolaria*, I prefer to place it there, despite its abnormal shape and ornamentation.

Modiolaria arcacea, *spec. nov.* Pl. ix., figs. 2*a*—2*b*.

Shell oblong, umbos marginal, very inflated, incurved, somewhat wide apart; anterior margin rounded, obliquely truncated posteriorly, dorsal line slightly arched; posterior area flattened, defined by a prominent umbonal ridge. Anterior radial area narrow, ribs rounded, crossed by lamellæ; posterior radial area extending over the umbonal ridge, rayed with flat ribs about as wide as the depressed interspaces, the whole crossed by equidistant lamellæ.

Dimensions.—Length, 27; height, 12; thickness through both valves, 18 millimetres.

Locality.—Turritella grits at Ardrossan (*O. Tepper*).

Modiolaria semigranosa, *spec. nov.* Pl. iii., fig. 5.

Shell oval-oblong, sub-diaphanous; umbo sub-marginal, rather depressed; anterior radial area obsolete, posterior radial area with sub-acute ribs about as broad as the inter-

spaces; ribs obsoletely granulo-nodulose, except on the flattened area posterior to the regularly rounded umbonal ridge, where they are covered by depressed imbricating lamellæ; inner margin of valve crenulated, denticulate under the umbo.

Dimensions.—Length, 7; height, 4·5 millimetres.

Locality.—Adelaide bore. A left valve (*R.T.*).

Modiolaria Corioensis, *spec. nov.* Pl. iii., fig. 4.

Shell oval-oblong, sub-diaphanous; umbo almost marginal, somewhat depressed, medial smooth area about two-thirds of the length of the shell; anterior radial area with about twelve acute ribs narrower than the angular interspaces; posterior radial area with about 30 flat ribs with linear interspaces. Inner margin of valve crenulated, denticulate under the umbo.

Dimensions.—Length, six; height, four millimetres.

Locality.—Corio Bay, Victoria (*R.T.*).

M. Corioensis is closely related to *M. impacta*, Hermann, and *M. Cumingiana*, Dunker; from the first it differs by its finer and numerous radii, and from the latter in being less gibbous and by its wider medial area.

Two other species of *Modiolaria* have been collected from the oyster banks of the Aldinga cliffs, but in a too exfoliated condition for diagnosis.

Crenella globularis, *spec. nov.* Pl. x., figs. 3*a*—3*b*.

Shell small, thin, translucent, sub-globose, pearly within, equivalve, inflated especially in the dorsal third; umbos a little anterior, obtuse, incurved, approximate; surface regularly cancellated; ligamental groove internal, lanceolate, extending posteriorly; hinge line bordering the ligamental area, minutely transversely denticulated; a small denticle terminates the ligamental groove under the umbo; margin of valves crenulated all round.

Dimensions.—Length, 5; height, 6; thickness through both valves, 7 millimetres.

Localities. — Glauconitic sands, Adelaide bore, many examples; gastropod bed, near Morgan, one example; Muddy Creek, Hamilton; Table Cape, one example (*R.T.*).

This fossil differs only specifically from *Stalagmium margaritacea*, Conrad=*Myoparo costatus*, Lea, of the Eocene of Alabama, which it resembles more than any other congener known to me; it is distinguished by its spherical shape and cancellated ornament. *C. elegans*, Deshayes, of the Parisian Eocene, is another closely related species.

FAMILY ARCADÆ.

SUB-FAMILY NUCULINÆ.

Genus Nucula.

SYNOPSIS OF SPECIES.

Shell smooth, margin not crenulated.	*N. tumida.*
Shell concentrically ridged and radially striated, margin crenulated.	
Obliquely trigonal, folds thin.	*N. Atkinsoni.*
More oblique, folds thick.	*N. semistriata.*
Trigonal, equilateral.	*N. Morundiana.*
Shell with fenestrated ornament.	*N. fenestralis.*

Nucula tumida, Tenison-Woods. Pl. vi., figs. 6*a*—6*b*.

Reference.—Proceedings Royal Soc., Tasmania, for 1877, p. iii.

Shell solid, obliquely trigonal, tumid, truncated posteriorly, slightly produced and rounded anteriorly, wrinkled with consecutive irregular, flattened folds of growth, increasing in thickness from the umbos to the margin; margin acute. Hinge teeth diverging progressively in an increasing series, interrupted by a narrow deep ligamental pit, which is obliquely produced posteriorly; the teeth are lanceolate, high, and lamellar, the distal ones smaller; in the posterior row there are eight, and in the anterior row about thirty. Umbos acute and sharply incurved; lunule shallow, but well defined, wrinkled and broadly lanceolate.

Dimensions.—Length, 21; height, 16; thickness through both valves, 14 millimetres.

Localities.—Tasmania: Table Cape (locality of the type) (*Tenison-Woods* and *R. M. Johnston!*).

Victoria: Muddy Creek, Hamilton (common and large); Corio Bay, Geelong; Schnapper Point, Port Philip.

South Australia: Gastropod bed, Middle Murravian, near Morgan (*R.T.*)

The author of this species states that it is "not unlike the Tasmanian *N. Grayii*, Sow., but is more tumid and conspicuously sulcate," distinctions which I confirm.

Nucula Atkinsoni, *R. M. Johnston.* Pl. iv., fig. 3*a*—3*c*.

Reference.—*Portlandia Atkinsoni*, R. M. Johnston, in Proc. Roy. Soc., Tasm., vol. for 1880, p. 39.

Shell small, obliquely trigonal, subdepressed; the very short posterior slope truncated. Surface of valves concentrically finely ridged; the ridges increase in size, and frequently anastomose towards the centre and margin, and are traversed

by fine radial threads, which form an open tessellated sculpture. Umbos sharply incurved; lunule shallow (scarcely defined), broadly lanceolate; ligamental pit inconspicuous; cardinal teeth lamellar, eight on the posterior and about 20 on the anterior slope. Edge of the ventral half of the valves minutely crenulated.

Dimensions.—Length, 7·5; height, 6·5; thickness through both valves, 4 millimetres.

Localities.—Table Cape, Tasmania (*R. M. Johnston*); Gastropod bed of the Middle Murravian, near Morgan (*R. T.*); Corio Bay, Geelong (*R. T.*).

The radial sculpture is not always visible by the aid of a pocket-lens, but the crenulated margin and the radial lines which proceed from it towards the interior are always discernible.

This shell has been wrongly placed in *Portlandia*, which is a *Yoldia* having the valves posteriorly closed, whilst it has the simple pallial line and other characters proper to *Nucula*.

Nucula semistriata, *spec. nov.* Pl. iv., figs. 5*a*—5*b*.

Shell small, obliquely trigonal, moderately depressed; the very short posterior side roundly truncated; anteriorly produced and rounded at the extremity. Surface with depressed folds of growth, somewhat retroflexed, the folds increasing in size, and here and there anastomising, towards the front where the interspaces are conspicuously radially ridged; posterior and anterior slopes radially striated. Umbos rather elevated, sharply recurved, lunule inconspicuous. Edge of valves crenulated. Ligamental pit scarcely defined.

Dimensions.—Length, 5·5; height, 4·25; thickness through both valves, 3 millimetres.

Localities.—Turritella clays, Blanche Point, Aldinga Bay; glauconite sands, Adelaide bore (*R. T.*).

This species differs from *N. Atkinsoni* by its greater obliquity and the thick retroflexed folds.

Nucula Morundiana, *spec. nov.* Pl. iv., figs. 2*a*—2*b*.

Shell minute, tumid, solid, trigonal, equilateral; posterior side obscurely angled and flattened above; anterior side obtusely rounded; umbones obtuse; surface ornamented with regular, equal rounded, concentric ribs, and microscopic radial striæ; inner margin of valves minutely denticulated.

Dimensions.—Length and height 3, thickness through both valves 2 millimetres.

Localities.—Muddy Creek, Hamilton, and the calciferous sandstones of the River Murray-cliffs near Morgan.

The specific name is derived from the aboriginal name of the Lower Murray River.

This minute shell is not the young of *N. Atkinsoni*, and differs from *Leda lucida*, T. Woods, by the equality of the transverse diameters of the valves.

Nucula fenestralis, *spec. nov.* Pl. iv., fig. 4.

Shell minute, ovate-oblong, somewhat tumid, umbo in the posterior-third; the shorter posterior side with a rounded margin; the anterior side roundly truncated. Surface ornamented by equidistant and equal-sized radial and concentric ribs; edge of valve crenulated.

Dimensions.—Length about 2, height about 1¼ millimetres.

Locality.—Table Cape, Tasmania (*R. T.*).

The peculiar feature of this fossil is the subcentral umbo and the gross cancellated sculpture.

GENUS LEDA.

SYNOPSIS OF SPECIES.

A. Non-rostrated; ovate-quadrate.	*L. obolella.*
More circular and depressed.	*L. planiuscula.*
B. Rostrated.	
Elongately-lanceolate.	*L. Huttoni.*
Elongately-oval.	*L. acinaciformis.*
Ovate-trigonal or pyriform	
Gradually acuminately-rostrated.	*L. apiculata.*
Abruptly rostrated and compressed.	*L. leptorhyncha.*
Oblong-ovate.	*L. lucida.*
Transversely-ovate, posterior side the shorter.	*L. prælonga.*
Rostral prolongation, biangulate.	
Oblong-subovate.	*T. Woodsii.*
Ovate-trigonal.	*L. crebricostata.*

Leda obolella, *spec. nov.* Pl. v., figs. 3*a*—3*b*.

Shell small, thin, ovate-quadrate, slightly inequilateral, depressed; umbos very small, slightly recurved, almost central; dorsal margin regularly sloping, anterior margin roundly truncate, the antero-dorsal area slightly depressed; posterior margin rounded, surface faintly concentrically striated; lunule obsolete; hinge teeth small, curved, about 15 on each side of a rather broad, erect, triangular cartilage pit.

Dimensions.—Length, 11·5; height, 9·5; thickness through both valves, 4 millimetres.

Localities.—Not uncommon at Muddy Creek; Schnapper Point; gastropod bed, Middle Murravian, near Morgan (*R.T.*).

This fossil differs from all living species, but has some re-

semblance to some species of *Yoldia;* it, however, does not belong to that genus, as the valves are closed, and the pallial sinus is small. It recalls some of the Jurassic species, notably *L. subovalis*, Goldfuss, of the European Lias.

Leda planiuscula, *spec. nov.* Pl. v., fig. 2.

Shell minute, similar to *L. obolella:* comparing equal-sized specimens of each, *L. planiuscula* is more depressed, and the outline approaches more to the circular.

Dimensions.—Length, 5; height, 4·5 millimetres.

Locality.—Adelaide bore.

Leda Huttoni, Tenison-Woods. Pl. vi., fig. 4.

Reference.—Proc. Linn. Soc., N.S.W., vol. iii., p. 239, tab. 21, fig. 2, 1878.

Shell small, depressed, thin, fragile, shining, transversely elongate, pyriform, concentrically irregularly striate and broadly sulcate, radially finely striated; posterior side much produced and slightly obliquely truncated at the end; obtusely triangulated. Anterior side short, rounded. Cardinal teeth numerous, minutely angular.

Dimensions.—Length, 11; height, 5 millimetres.

Localities.—Muddy Creek, Hamilton, where it is common!; Table Cape!; Adelaide bore; and Turritella clays, Aldinga (*R.T.*).

The specimens from Adelaide and Aldinga are a little more inflated, and the anterior side shorter, whilst the post-dorsal margin is sloping and not elevated at the end; the arched rostral prolongation is very conspicuous in young shells from Muddy Creek, but the character is not constant.

Leda acinaciformis, *spec. nov.* Pl. v., figs. 6*a*—6*b*.

Shell depressed, elongate-oval; umbo subcentral; anterior side rounded; dorsal margin sloping anteriorly, and slightly elevated at the posterior end; ventral margin strongly arcuate, curved upwards posteriorly to form a rostral prolongation. Umbonal ridge well defined, above which is a narrow lanceolate area. Surface sculptured with concentric, thick, flattened ribs. The regular convexity of the anterior surface is interrupted by a narrow, flattened, triangular area extending from the umbo to the antero-ventral margin, rendered conspicuous by the interrupted curve of the concentric ribs. Lunule lanceolate, longitudinally ridged.

Dimensions.—Length, 17; height, 8; thickness through both valves, 6 millimetres.

Locality.—Muddy Creek.

L. acinaciformis has the general form and ornament of

L. crassa, Hinds, its nearest ally in recent creation, from which it differs in its depressed elongated shape.

Leda apiculata, *spec. nov.* Pl. ix., figs. 4*a*—4*b*.

Shell ovate-subtrigonal, ventricose, inequilateral; umbo moderately inflated, rounded, recurved, in the anterior half. Anterior side inflated, rounded; ventral border arched, posterior side shortly acuminately rostrated; antero-dorsal margin sloping, post-dorsal area depressed, slightly elevated at the end. Whole surface marked with concentric raised threads narrower than the interspaces. Lunule well defined, striated; cardinal teeth about fifteen on each side of a small triangular ligamental pit.

Dimensions of figured specimen.—Length, 9·5; height, 5·5; thickness, 4 millimetres; of a larger example the longitudinal and transverse diameters are 11 and 6·5 millimetres respectively.

Localities.—Abundant in the Turritella clays at Blanche Point, Aldinga Bay; also in the glauconite sands, Adelaide bore; Muddy Creek and Schnapper Point, Victoria.

Leda leptorhyncha, *spec. nov.* Pl. x., figs. 5*a*—5*b*.

Shell minute pyriform, subventricose, much inflated in the middle; umbos subcentral, slighty elevated and recurved. Anterior side rounded, with the dorsal margin sloped; ventral border arched very abruptly sloping upwards posteriorly; posterior side a little the longer, much compressed, and acuminately rostrated above. Surface marked with concentric ridges and striæ, more or less obsolete on the beak. Lunule narrow lanceolate. Cardinal teeth, about 15 on each side of a small but well-defined triangular cartilage pit.

Dimensions.—Length, 5; height, 3; thickness through both valves, 2 millimetres.

Localities.—Turritella marls, Aldinga Bay; glauconite sands, Adelaide bore. Very common.

This species is not the young of *L. apiculata*, from which it differs by the contraction and compression beneath the rostrum, by its irregular sculpturing, and by its shape. Examples of *L. apiculata* of the size of the present species differ from the adult only by the post-dorsal side being straight, not elevated at the end.

Leda lucida, Tenison-Woods. Pl. vi., figs. 7*a*—7*b*.

Reference.—Proc. Linnean Soc., N.S.W., vol. iv., p. 3, t. 1, fig. 5 (1879).

Shell thick oblong, subventricose, umbo almost central, depressed, very slightly recurved; dorsal margin sloping an-

teriorly; anterior side rounded; ventral margin rather straight in the middle, abruptly sloping upwards posteriorly; posterior side somewhat angular, shortly acuminate above. Surface marked with concentric folds and striæ of growth. Lunule well-defined, elliptical, striated; cardinal teeth, 20 in front row, 15 in the posterior row.

Dimensions.—Length, 18; height, 11; thickness through both valves, 8 millimetres.

Localities.—Corio Bay; common at Muddy Creek; Schnapper Point; and near Morgan (*R. T.*)

L. lucida was established upon a minute shell, which I have been enabled to trace through various stages of growth to the moderately large-sized example figured on pl. vi., fig. 7. The original diagnosis reads as follows:—"Shell small, tumid, solid, polished, equilateral, almost ovate, regularly concentrically ribbed; ribs rounded equal; posterior side scarcely produced, subacutely angular, posterior angle scarcely sulcate; anterior side short, obtusely rounded, umbone subacute. Long. 3·5, lat. 5·5, alt. 2 millimetres. Muddy Creek."

Professor McCoy, in Rep. Geol. Surv. Victoria, 1875, p. 22, figures the cast of a shell obtained at Stawell, which he says "is the *Nucula Marthæ* (McCoy), an extinct species common in the Oligocene Tertiary beds between Mount Eliza and Mount Martha." I have no doubt that the *N. Marthæ* above referred to is conspecific with *L. lucida*, though of the many examples in all stages of growth from that particular locality which I have examined, I cannot find one to match the drawing in the Geol. Surv. Report. The drawing may imperfectly represent the shell; however, as it does not serve for identification, and as no diagnosis has been published of the species, I prefer to employ the name given by Tenison Woods.

Leda prælonga, *spec. nov.* Pl. xii., figs. 4*a*—4*b*.

Shell small, transversely ovate, very inequilateral, rather compressed, smooth, shining; umbones post-median, inconspicuous; anterior side ventricose, rounded, produced; posterior side short, rather attenuated and bluntly acuminate; valves closed; pallial sinus conspicuous.

Dimensions.—Length, 4; height, 2; thickness through both valves, 1 millimetres.

Localities.—Table Cape, Tasmania; and Muddy Creek, Hamilton, Victoria.

This is a very distinct species, and cannot be mistaken for young examples of associated species; it makes some approach to *L. leptorhyncha*, but differs from it by its shape and the position of its inconspicuous umbones.

Leda Woodsii, *spec. nov.* Pl. ix., fig. 8.

Synonym.—*L. inconspicua*, Tenison-Woods, in Proc. Linn. Soc., N.S.W., vol. iii., p. 139, t. 21, fig. 3, 1878 (*non* A. Adams).

Shell small, compressed, oblong subovate; umbos post-median, small, depressed; posterior side rather longer than the anterior side, obtusely truncated and acuminated at the end; anterior side rounded, somewhat attenuated; dorsal margin sloping anteriorly, nearly straight posteriorly. An angular posterior ridge originating at the umbo circumscribes a triangular depressed area. Surface finely concentrically ribbed, less conspicuously so on the anterior side; the ribs pass over the umbonal ridge on to the depressed area above. Lunule ill-defined, narrow elongate; ligamental pit triangular, deeply sunk.

Dimensions.—Length, 12; height, 6; thickness through both valves, 3·5 millimetres.

Localities.—Muddy Creek, Hamilton (*Ten. Woods!*); gastropod bed, Middle Murravian, near Morgan (*R.T.*).

The Rev. J. E. Tenison-Woods figures a young shell of this species under Adams' name of *L. inconspicua*. Certainly it closely resembles Reeve's figure of that species, but at later stages of growth the resemblance ceases, and the general form is that of *L. Dorhnii*, Hanley. Without specimens it would not be possible, I think, to differentiate the fossil from the living species above named; but the result of an actual comparison of specimens is that the fossil differs in the following particulars:—Hinge line more arched, anterior side more attenuated, the concentric ridges more numerous and finer.

Young examples of *L. Woodsii* differ from *L. crebrecostata*, Woods, in being more oblong and with finer concentric ridges, both agreeing in the short triangulated rostral prolongation.

Leda crebrecostata, Tenison-Woods. Pl. v., figs. *5a—5b*.

Reference.—Proc. Royal Soc., Tasmania, vol. for 1877, p. .

Shell small, moderately depressed, transverse trigonal, narrowly oblong; umbo post-median; anterior side the longer roundly obtuse, posterior side shortly rostrated, triangular, rather compressed and obtusely truncated at the end. Surface regularly concentrically ridged with equal rounded ribs.

"Hinge line inconspicuous and short, anterior subligamental area distinct.

"Transverse length, 5; breadth, 8; thickness of both valves joined, 3 millimetres" (*T. Woods*).

Locality.—Table Cape (*R. M. Johnston!*).

It is smaller and less oblong than *L. Dohrnii*, Hanley, but like it distinguished by the abrupt angulation of the posterior margin and the concentric thick rounded ridges.

SUB-FAMILY PECTUNCULINÆ.

Genus Limopsis.

SYNOPSIS OF SPECIES.

Smooth or concentrically wrinkled, radial lines absent or not prominent.
  Elongate-ovate, no radial ornament. *L. insolita.*
  Ovate-orbicular; thick, concentrically ridged, and finely radiately striated. *L. aurita.*
Radial ornament prominent.
  Radial ribs simple; cancellate. *L. Belcheri.*
  Radial ribs bifurcate; strong concentric folds. *L. multiradiata.*

Limopsis insolita, *G. B. Sowerby.*

References.—*Trigonocælia insolita*, Sow. in Darwin's Geol. Obs. on S. America, 1846; p. 608, t. ii., figs. 20-21., 2nd ed. *Limopsis insolita*, Zittel in Voy. Novara, Palæont., p. 48, t. xiii., fig. 1, 1864; *id.*, Hutton, Cat. Tert. Moll. of New Zealand, p. 28, 1873.

Localities.—South Australia: in a black clayey sand at the base of the sea cliff, half mile north of jetty in Aldinga Bay, very abundant; in a similar bed, Adelaide bore. New Zealand: Pareora Series, at Nelson, Kaniera, Waikari (*Hutton*); also Santa Cruz, Patagonia (*Darwin*).

Limopsis aurita, *Brocchi.*

References.—*Arca aurita* (Br.), Conch. Foss. Subapenninæ, t. xi., fig. 9. *Limopsis aurita*, McCoy, Prodr. Pal. Victoria, Dec. II., t. xix., figs 5-7 (1875).

Synonym.—*Limopsis Zealandica*, Hutton, Cat. Tert. Moll., N.Z., p. 28 (1873).

Localities.—Victoria: At Bird-rock Point, near Geelong; at Schnapper Point and at Mornington, Port Phillip (*McCoy*); Muddy Creek (*R. T.*). Tasmania: Table Cape (*R. M. Johnston*). Also fossil in European Miocene and Pliocene, and recent in the Arctic and Southern Oceans.

Limopsis Belcheri, *Adams* and *Reeve.*

References.—*Pectunculus Belcheri*, Adams and Reeve, in Voy. of the Samarang, t. xxii., f. 5, p. 76 (1850). *Limopsis Belcheri*, McCoy, Prodr. Pal. Victoria, Dec. II., t. xix., figs. 8-9 (1875).

Localities.—Victoria: Balcombe Bay!; Muddy Creek!; Moorabbin; Corio Bay; and west of mouth of Gellibrand River (*McCoy*). South Australia: Calciferous sandstone near Morgan on the River Murray; raggy limestone at Edithburg, Yorke Peninsula. Recent off the Cape of Good Hope

(Samarang Exped.); St. Vincent Gulf, Guichen Bay, and Portland, Southern Australia.

Limopsis multiradiata, *spec. nov.* Plate xii., figs. 1*a*—1*b*.

Shell ovate-orbicular, slightly inequivalve and oblique, thick, convex; umbones prominent, concentrically irregularly folded and radially ribbed; ribs thin, very numerous, narrower than interspaces, bifurcating at about the middle; cartilage pit large, equilateral, three or four very small teeth under it, six or seven larger ones on each side.

Dimensions.—Length from umbo to the post-ventral margin, 9.5; greatest width, 10; thickness through both valves, 5 millimetres.

Localities.—Glauconite argillaceous sands, Adelaide bore; and Turritella limestone bands, Blanche Point, Aldinga Bay.

Among the Australian congeners this species resembles *L. aurita*, somewhat in shape though less oblique, and the undulating folds are thick and irregular. The conspicuous radial ribs ally it to *L. Belcheri*, which is distinguished by a peculiar style of tesselated sculpture produced by wavy concentric fringes; in *L. multiradiata* the radial ribs bifurcate, and only in young shells is there present a fenestrated ornament produced by the crossing of simple concentric threads.

LIMARCA, *gen. nov.*

Derivation from Lima and Arca. Type, L. angustifrons, spec. nov.

Very inequilateral; cartilage pit lanceolate, excavated on the hinge line, directed backwards; hinge line with anterior denticles and posterior elongated longitudinal teeth. No area under the umbo.

L. iniquidens, Sanberger, in Die Conchylien des Mainzer Tertiarbeckens, 1863, p. 347, t. 29, fig. 5, is apparently congeneric.

The characters of the cardinal region recall *Crenella* in Mytilidæ, but the muscular impressions determine its place in Arcadæ, whilst its similitude to *Limopsis* is great. It agrees with *Trigonocœlia* in the absence of an area between the umbo and the hinge line, and in this particular differs from *Limopsis* and *Cyrilla;* from *Trigonocœlia* it differs by the fewness of the cardinal teeth, the posterior of which are longitudinal and not cross-set.

Limarca angustifrons, *spec. nov.* Plate viii., figs. 5*a*—5*b*.

Shell small, subrhomboidal, convex, equivalve, very inequilateral; anterior margin regularly rounded; posterior roundly truncated; ventral margin regularly convex outwardly. Sur-

face ornamented with broadish depressed transverse and narrow radial ribs. Umbones minute, subterminal, obtuse; no area; hinge-line thick, obtusangular; ligamental pit excavated in the hinge-line, oblique, lanceolate, directed backwards; anterior to the pit are three suberect denticles, and posteriorly four longitudinal teeth. Internal margin of valves crenulated, more prominently so in the posterior part.

Dimensions.—Length from umbo to post-ventral margin, 5·5; width, 5·5; thickness through both valves, about 4 millimetres.

Localities.—Turritella-beds, Blanche Point, Aldinga Bay, and glauconitic argillaceous sands, Adelaide bore.

This species has a general resemblance to *L. iniquidens*, Sandb., but wants the auriculated antero-dorsal margin, and has fewer hinge teeth.

Genus Pectunculus.

synopsis of species.

I. Finely radially striated.	
Orbicular, slightly oblique.	*P. Cainozoicus.*
II. Radially ribbed.	
Ribs, about 39; wider than long.	*P. laticostatus.*
Ribs, about 29; longer than wide.	*P. McCoyii.*
Ribs, about 29; subtrigonal.	*P. subtrigonalis.*
Ribs, about 24, elevated; orbicular, tumid.	*P. convexus.*
Ribs, 40 or more; orbicular, depressed.	*P. lenticularis.*

Pectunculus Cainozoicus, *T. Woods, sp.* Plate x., figs. 8*a*—8*b*.

Reference.—*Cucullæa Cainozoica*, T. Woods, Proc. Roy. Soc., Tasmania, for 1876; p. 111.

"Shell roundly trigonal, oblique, globose, smooth, faintly and closely marked with radiating ribs and concentric striæ, the latter well defined and somewhat rugose at the margin and sides. Umbones very acute and recurved. Ligamental area arched, broad, with six straight grooves on each, which are well defined, and overlap each other alternately under the umbo; hinge-teeth, 6-7, bent under the hinge, and then bicuspidate. Margin of valves finely pectinated with very distinct crenulations, which continue in young shells all round as far as the hinge. Young shells are also more quadrate, and have the angular ears slightly developed" *(T. Woods)*.

Var., pl. x., figs. 8*a*—8*b*.—This differs from the type in being more orbicular, less narrowed at the hinge-line—characters very conspicuous in young shells. The variety is hardly separable from *P. pulvinatus*, Lamk., of the Parisian Eocene, which is, however, more gibbous at the umbones, and is equilateral.

Dimensions.—Length, 45; width, 42; thickness through valves, 33 millimetres.

Localities.—*Type*, Table Cape (*R. M. Johnston!*). *Var.*, common at Muddy Creek; Adelaide bore.

Pectunculus laticostatus, Quoy and Gaimard (?).

References.—Voy. de l'Astrolabe, t. 77, figs. 1-6, vol. iii., p. 466, McCoy, Prod. Pal., Victoria, Dec. ii., t. xix., figs. 10-14.

Localities.—Bird Rock, Geelong; of small size, Schnapper Point (*McCoy*).

This identification of the fossil and the living species has been disputed by Mr. R. M. Johnston. The material at my command is not sufficient to permit me to express an opinion, though I have little hesitation in accepting Prof. McCoy's determination in respect to the fossils represented by fig. 10.

Pectunculus McCoyii, R. M. Johnston.

Reference.—Proc. Roy. Soc., Tasm., for 1884, p. 199.

The characteristic shell of Table Cape, previously referred to the living species, *P. laticostatus*, is regarded by Mr. Johnston as specifically distinct, with the following differential characters:—Ribs, 29 (not 39), less solid, longer than broad, more convex towards the margin; hinge teeth, 10.

A thin, sub-orbicular, narrowed at the hinge, depressed shell, never exceeding 30 millimetres diameter, very abundant at Muddy Creek, is tentatively included under *P. McCoyii*.

Localities.—Table Cape, Tasmania; Cape Schank, Victoria (*R. M. Johnston!*); Muddy Creek and Schnapper Point (*R.T.*).

Pectunculus subtrigonalis, *spec. nov.* Pl. xi., figs. 6*a*—6*b*.

Shell solid, somewhat sub-trigonal, sub-equilateral, oblique, slightly produced posteriorly, moderately convex, radiately ribbed; ribs about 29, rounded, separated by flat narrower interspaces, the whole surface crossed by regular, sub-distant, subimbricating lamellæ, and a few folds of growth; umbones small, approximate; hinge line very short, ligamental area small; cardinal teeth eight in front and seven behind the edentulous centre; internal margin of valves strongly crenate.

This species is conspicuous by its narrow hinge line, the valves attaining the greatest transverse diameter at about four-sevenths the distance from the umbo to the front.

Dimensions.—Length, 32; width, 31; thickness through both valves, 19 millimetres.

Localities.—Common in the calciferous sandrock of the River Murray cliffs near Morgan (*R.T.*); rare Muddy Creek (*J. Dennant!*).

Pectunculus convexus, *spec. nov.* Plate xi., figs. 7*a*—7*b*.

Shell solid, orbicular, but slightly transverse, tumid; sub-equilateral; umbones approximate, radiately ribbed. Ribs about 24, rounded, elevated, interspaces concave wider than the ribs, crossed all over with thick concentric wavy laminæ becoming finer towards the front. Inner margin of valves strongly crenate. Cardinal teeth about ten on each side.

Dimensions.—Length, 31; width, 33; thickness through both valves, 22 millimetres.

Localities.—Muddy Creek. Imperfect specimens oyster banks North-west Bend on the R. Murray; Hallett's Cove and Aldinga Bay.

This species has some resemblance to the recent *P. flabellatus*, T. Woods, but is more inflated and with wider interspaces between the ribs.

Pectunculus lenticularis, *spec. nov.* Plate xi., fig. 1.

Shell rather thin, orbicular, but slightly transverse, depressed, equilateral; radiately ribbed. Ribs numerous (more than 40), very fine, rounded, narrower than, or about as wide as, the interspaces, crossed all over with fine concentric wavy lines. Inner margin of valves narrowly toothed; umbones very small, approximate; ligamental area very small, cardinal teeth 11 on each side.

Dimensions.—Length, 31; width, 29; greatest thickness through both valves, at about one-third the distance from the front, 12 millimetres.

Locality.—Glauconitic sands, Adelaide bore.

SUB-FAMILY ARCINÆ.

Synopsis of Species.

Arca.

Valves gaping ventrally; umbones high, wide apart.

Hinge teeth numerous, transverse. *A. pseudonavicularis.*

Hinge teeth few, all oblique. *A. equidens.*

Barbatia.

Valves closed or sinuated ventrally; umbones approximate; teeth numerous, transverse, gradually becoming larger and more oblique towards the extremities.

Transversely oblong; left valve radially ribbed; right valve smooth, with contused impressions. *B. dissimilis.*

Oblong with concentric ridges thickly granulose or plicate; gibbous. *B. crustata.*

Elongate-oblong, with concentric fimbriated ridges. *B. celleporacea.*

Surface with granular ribs.
Elongate, suboval; umbones subanterior. *B. limatella.*
Id., posterior side attenuated. *B. consutilis.*
Trapezoidal, posteriorly keeled; umbones anterior. *B. simulans.*
Ovate-oblong; strongly ribbed on the posterior slope. *B. pumila.*

MACRODON.

Valves closed; umbones approximate; posterior teeth laminar horizontal; anterior teeth few, short, oblique.
Sculpture of flat concentric ridges transversed by distant riblets. *M. Cainozoicus.*

Arca pseudonavicularis, *spec. nov.* Pl. xi., fig. 8.

Shell elongate, subtrapeziform, tumid; front margin obliquely rounded; posterior margin somewhat attenuated, obliquely truncated, with the posterior slope strongly angulated; hinge line straight. Umbones anterior, distant, acute; ventral margin sinuately excavated; inner margin of valves plain. Surface ornamented with concentric fimbriated folds; posterior slope unequally, radiately ribbed. In young specimens the surface is unequally cancellated, and the radial ribbing on the anterior and posterior areas is very pronounced. Hinge area broad, with a well defined triangular area under the beak; teeth very numerous, small, transverse.

Dimensions.—Greatest length, 27; width, 12·5; thickness through both valves, 14 millimetres.

Localities.—Adelaide bore (*R.T.*); Table Cape (*R. M. Johnston!*).

The living analogue of this species is *A. navicularis*, Brug., as known to me from Port Darwin, from which it differs in the umbones being not near the front, in the somewhat emarginate anterior side, and in the finer ribbing on the posterior slope.

Arca equidens, *spec. nov.* Pl. xi., fig. 9.

Shell elongate-oblong, tumid, with a depression extending from the umbo to the ventral margin, which is somewhat insinuated; anterior side acutely angular, posterior side elongated, obtusely angular or truncated, with a roundly angular posterior slope; hinge line straight. Umbones at the anterior third, narrow, acute, wide apart. Surface with concentric, imbricating ridges and radial threads or ribs. The ornament varies in respect to the relative strength of the radial ribs and concentric ridges; in some it is of the nature of fimbriated concentric ridges, whilst in the other extreme it consists of radial ribs variously thickened at the intersections with the

concentric lines. Inner margin of valves not crenulated. Hinge area broad, longitudinally fine-lined; central tooth V-shaped, succeeded on each side by about seven equal lamelliform oblique teeth, delicately crenulated on the sides.

This species cannot be mistaken for *Arca pseudonavicularis*, whilst the character presented by the hinge teeth separates it from all congeners.

Dimensions.—Length, 8·5; width, 4; thickness through both valves, 6 millimetres.

Localities.—Abundant in the lower beds Blanche Point, Aldinga; and Adelaide bore.

Barbatia dissimilis, *spec. nov.* Pl. xi., figs. 4 and 5.

Shell transversely - oblong, somewhat tumid, obliquely rounded in front, subobliquely truncated behind, with a roundly angulated posterior slope. Umbones at about the anterior-third, acute, moderately wide apart; ventral and dorsal margins nearly parallel, front margin not sinuated. Left valve ornamented with radial ribs crossed by concentric threads, producing imbricating granulations at the intersections. Right valve with equidistant concentric folds, with pitted sculpture between them. The peculiar sculpture may be the scars of deciduous imbricating scales, traces of which are preserved on the posterior and anterior slopes, particularly on the former, where they are grouped in radial lines. Hinge area narrow, with a few marginal longitudinal ridges, and a transverse lanceolate groove beneath the beak and indenting the hinge line. Teeth few, large, transverse, but becoming slightly oblique towards the ends; about eight in front, and about fourteen behind the umbo.

Localities.—Very common in the Turritella limestone bands, Blanche Point, Aldinga Bay; and in the argillaceous glauconitic sands, Adelaide bore.

Dimensions.—Length, 7; width, 5; thickness through both valves, 4 millimetres.

Barbatia crustata, *spec. nov.* Pl. ii., fig. 16.

Shell small, oblong, tumid, medially impressed, and sinuated ventrally. Umbones broad, incurved, approximate, anterior. Anterior side short, roundly truncate; posterior side elongated, obtusely truncated; posterior slope very narrow, precipitous. Surface with thick concentric lamellæ, radially plicate or granular. Inner margin of valves plain; hinge teeth numerous, small, transverse.

Dimensions.—Length, 7; width, 3·5; greatest thickness through both valves on the posterior ridge, 6 millimetres.

Locality.—Oyster beds of the River Murray cliffs at the North-West Bend.

Has a resemblance to *Arca equidens*, mihi, but with a coarser ornament, shorter posterior side, &c.

Barbatia celleporacea, *spec. nov.* Pl. x., fig. 10.

Shell elongate-oblong, rather compressed, inequilateral; anterior side short, narrow, acutely angular; posterior side elongated, obtusely angular, with the posterior slope carinated; ventral side slightly sinuated. Hinge line straight. Umbones anterior, approximate, depressed, acute. Surface ornamented with concentric folds raised into frills; the latter in aged specimens pass into uncinate scales or hollow tubercles, the fimbriations within the interstitial spaces not infrequently perforated, the entire ornamentation simulating a polyzoal growth, as in *Cellepora*. The concentric folds show coarse distant growth lines. Internal margin strongly crenulated; ligamental area very narrow; teeth small, numerous in a transverse series, increasing in size and becoming slightly oblique towards the extremities.

Dimensions of a large specimen:—Greatest length, 26; width, 10; thickness through both valves, 7·5 millimetres.

Localities.—Victoria: Common at Muddy Creek; Schnapper Point (*R.T.*). Tasmania: Table Cape (*R. M. Johnston!*).

This species has much resemblance to *Barbatia* (*Acar*) *laminata*, Angas, inhabiting South Australian waters, and therefore to *Arca squamosa*, Lamk., but it is more elongate, not so tumid, with narrow acute umbones, and the front margin more angular.

Barbatia limatella, *spec. nov.* Plate x., fig. 2.

Shell elongate suboval, moderately inflated, inequilateral; umbones subanterior, incurved very close together; anterior side short, rounded; posterior margin obliquely roundly truncated; hinge-line straight; ventral margin straight or slightly arcuate, slightly insinuated medially. Surface radiately fine-ridged, dichotomously dividing, more or less granulose or scaly where crossed by the numerous equidistant imbricating folds; the depressed posterior slope conspicuously radiately ridged. Hinge area very narrow, almost wanting in young specimens, divaricately furrowed; central teeth numerous, small, transverse, with a few short, oblique, fold-like teeth towards the extremities.

Dimensions of a large specimen.—Length, 50; width, 28; thickness through both valves, 19 millimetres.

Localities.—Sandy clays at Blanche Point, Aldinga Bay, and argillaceous glauconitic sands, Adelaide bore.

The living analogues of this fossil species are *B. lima*, Reeve, and *B. decussata*, Sby. From the first it differs in its coarser ornament, particularly on the less angular posterior slope, and in its longer posterior side. From the second, with which it agrees well in ornament and in general shape, it differs by its longer and straighter hinge-line, longer posterior side, and by the stronger and more laminar and oblique teeth on the marginal areas.

Barbatia consutilis, *spec. nov.* Plate ii., fig 15.

Shell elongate-oval, moderately convex, medially impressed; umbones subanterior, incurved, close together; anterior side short, rounded; posterior side elongated, attenuated, obliquely truncated. Surface radiately fine ridged, more or less granulose where crossed by the equidistant concentric threads; the worn surface regularly tessellated.

Dimensions of a large specimen.—Length, 41; width, 20; thickness through both valves, 16 millimetres.

Locality.—Common at Muddy Creek.

Similar to *B. limatella*, but especially distinguished by its attenuate posterior side.

Barbatia simulans, *spec, nov.* Plate xi., fig. 10.

Shell transversely trapezoidal, moderately inflated, very inequilateral, umbones anterior, incurved, close together; anterior margin very short, obtusely roundly truncate, posterior side elongated, obtusely truncated with a well-defined posterior slope; hinge-line straight; ventral margin inconspicuously insinuated. Surface with flattish granular ridges wider than the interspaces. Hinge area very narrow, with about seven divaricating cartilage furrows; teeth numerous, transverse, becoming more oblique towards the extremities.

Dimensions.—Length, 34; width, 19; thickness through both valves, 14 millimetres.

Localities.—Muddy Creek, Hamilton; oyster banks, North-West Bend, on the R. Murray.

This species is closely related to *B. lima* and *B. limatella* from which it is distinguished by the shorter anterior side, obtusely truncated, and by its granular ornamentation most conspicuously so on the posterior slope. *B. limatella* wants the posterior angulation of this species.

Barbatia pumila, *spec. nov.* Pl. x., fig. 7.

Shell small, ovate-oblong, moderately convex, inequilateral; umbones anterior, rather broad, obtuse, approximate; anterior side short, rounded; posterior side depressed, subangular, its margin obtusely roundly truncate; dorsal and ventral margins

straight; valves closed, inner margin crenulated, conspicuously so on the posterior side. Surface ornamented by flatly rounded radial ribs, broader than the interspaces, and concentric striæ and folds, producing granular thickenings at the intersections; the radial ribs are very prominent on the posterior slope. Hinge area very narrow, teeth numerous, transverse, becoming larger and slightly oblique towards the extremities.

Dimensions.—Length, 9; width, 5; thickness through both valves, four millimetres.

Locality. — Not uncommon in the upper beds at Muddy Creek, Hamilton.

Macrodon Cainozoicus, *spec. nov.* Pl. x., fig. 4.

Shell elongate, subrhomboidal, somewhat compressed, inequilateral; anterior side short, acutely angular, somewhat acuminate; posterior side elongated, truncated with a well defined posterior slope; hinge line straight; ventral margin insinuated in the middle, the antero-ventral line rapidly ascending. Umbones subanterior, not widely separated, slightly incurved. Surface with concentric flat ridges, broader than the deep sulci, and radial threads interrupted by the furrows. Internal margins of valves smooth; ligamental area narrow, with a few longitudinal ridges; teeth radiating from an edentulous centre, five or six anterior, short, oblique; posterior several, laminar, parallel with the hinge line.

Dimensions of a large specimen:—Length, 27; width, 10; thickness through both valves, 9 millimetres.

Localities.—South Australia: calciferous sandstones, River Murray Cliffs, near Morgan; Adelaide bore; Aldinga. Victoria; Schnapper Point, Muddy Creek and Corio Bay (*R.T.*).

Prof. Hutton, in Trans. N.Z. Institute, vol. xvii., p. 331, 1885, describes an ark under the name of *Macrodon australis*, which I think, after examination of an authentic specimen, would be better placed in the genus *Cucullæa*. My species does not conform with the typical species of the genus, but it is generically identical with certain Jurassic and Cretaceous forms which have been associated therewith.

Genus Cucullæa.

SYNOPSIS OF SPECIES.

Very gibbous, with granulated ridges. *C. Corioensis.*
Not so gibbous; umbones narrower, ribs more numerous, narrower, and finer. *C. Adelaidensis.*

Cucullæa Corioensis, McCoy.

Reference.—Prodr. Pal., Victoria, Dec. III, t. 27, figs. 3-5, 1876.

Localities.—Victoria: common at most of the localities; Corio Bay; Bird Rock Point; Point Addis; Gellibrand River; Muddy Creek!; Mordialloc; Dog Island, Leigh River; Bairnsdale; Jemmy's Point, Gippsland Lakes; Schnapper Point (*McCoy*).

Tasmania: Table Cape! (*R. M. Johnston*).

South Australia: very common in the calciferous sandrock of the R. Murray Cliffs, near Morgan; in a well-sinking at the Nine-mile Camp, near Morgan; casts in the hard calciferous sandstones associated with the oyster banks at Aldinga and Adelaide (*R.T.*)

Cucullæa Adelaidensis, *spec. nov.* Pl. xi., fig. 14.

Shell obliquely trapezoidal, very tumid, inequilateral; umbones large, incurved, slightly in front; anterior margin rounded, ventral margin straight, oblique to the straight hinge line; posterior margin slightly undulating, obtusely truncated; posterior slope flattened, separated from the moderately convex rest of the valve by an obtusely rounded ridge extending from the umbo to the post-ventral margin. Surface ornamented with fine, narrow, radial riblets, not much wider than the impressed furrows, crossed by numerous close-set retroflexed laminæ of growth. In the umbonal region the transverse laminæ are wider apart, and at the intersections form granulations, but towards the front they are more crowded, and are raised on the riblets into squamæ. The radial riblets increase by bifurcation, and at the proximal end the duplication is indicated by a linear sulcus. Inner margin of the valves coarsely ridged. The ligamental area is marked with five impressed divaricating furrows. There are three or four anterior and four or five posterior longitudinal laminar teeth. The central teeth are small and transverse, and increase in size and obliquity outwards. The post-adductor muscular impression with a thickened, but not elevated, inner margin.

Dimensions of an average-sized specimen:—Length from antero-dorsal to post-ventral margin, 44; width from umbo to ventral margin, 29; thickness through both valves, 30.

Locality.—Many specimens obtained from the glauconitic sands, Adelaide bore.

This species closely resembles *C. Corioensis*, but may at a glance be distinguished by its more oblique outline and finer sculpture; also it is less tumid, the umbones not so wide, and the radial ribs are narrower and more numerous.

FAMILY TRIGONIIDÆ.

Genus Trigonia.

SYNOPSIS OF SPECIES.

Transversely ridged on the anterior two-thirds of the valves; posterior slope radially ridged.
- Ridges plain. *T. semiundulata.*
- Ridges with tubular projections. *T. tubulifera.*

Whole surface of valves radially ridged.
- Ribs acute with spinous tubercles. *T. acuticostata.*
- Ribs thick, anterior ones with blunt tuberculations. *T. Howitti.*

Trigonia semiundulata, McCoy.

References.—Geological Magazine, vol. 3, p. 481, and Pal. Victoria, Dec. II., pl. xix., figs. 4, 5.

Localities.—Victoria: very abundant in the sandy beds of Bird Rock Bluff, near Geelong (*McCoy*); Muddy Creek (*R.T.*); Tasmania: Table Cape! (*R. M. Johnston*); South Australia: silicified sandstone blocks in the sharp sands underlying the pebble bed at Gawler (*R. T.*). Also quoted by Hutton from the Pareora Series at Awamoa, New Zealand.

Trigonia tubulifera, Tate, Plate xi., figs. 13*a*—13*b*.

Reference.—Southern Science Record, January, 1885, p. 3.

Shell minute, quadrate; the flattish posterior area with about 16 thin radial ribs beset with truncate tubular projections; the remainder of the surface with about 20 concentric ribs similarly ornamented.

The tubular projections are short though conspicuous, and are separated one from the other by intervals not much wider than the tubes. Only two examples have occurred to me—one, a left valve, from Schnapper Point, on which the two areas are well-marked, the other, a right valve, from Muddy Creek, has the anterior area so masked by the long tubular projections as to conceal the concentric arrangement of the ribs.

Length and height, about 5 millimetres.

Trigonia acuticostata, McCoy.

References.—Geological Magazine, vol. 3, p. 482, and Pal. Victoria, Dec. II., pl. xix., figs. 1, 2.

Localities.—Muddy Creek and Mordialloc, Victoria (*McCoy*); oyster beds of the Upper Murravian at the North-west Bend Head Station, R. Murray, in South Australia (*R. T.*) Casts, probably of this species in beds of the same age at Tickera near Wallaroo, and at Aldinga.

It has been reported by Prof. McCoy (Ann. and Mag. Nat. Hist., 1876, p. 273) living in Bass Straits.

Trigonia Howitti, McCoy.

Reference.—Palæontology of Victoria, Dec. III., pl. xxvii., figs. 1—2*c*, 1876.

Locality.—Sandy marl at Jemmy's Point, near the entrance of the Gippsland Lakes, collected by Mr. A. Howitt, after whom it is named.

FAMILY CRASSATELLIDÆ.

Genus Crassatella.

SYNOPSIS OF SPECIES.

A. Valves with plain margins.
- Elongate ovate-trigonal. *C. oblonga.*
- Subquadrate; fine concentric folds. *C. astartiformis.*
- Subquadrate; tumulous concentric ridges. *C. corrugata.*
- Subtriangular, anterior side very short, fine concentric folds. *C. abbreviata.*

B. Valves with crenated margins in the adult.
- Ovate-oblong; concentrically folded. *C. Dennanti.*
- Ovate-trigonal; nearly smooth. *C. aphrodina.*

Crassatella oblonga, *Tenison-Woods.*

Reference.—Proc. Roy. Soc., Tasm., for 1875, t. ii., fig. 11, p. 25.

Localities.—Tasmania: Table Cape! (*R. M. Johnston*). Victoria: Muddy Creek. South Australia: Oyster beds, North-West Bend, River Murray.

Very distinct from any existing species; is somewhat like *C. attenuata*, Hutton, of the Older Tertiary, New Zealand.

Crassatella Dennanti, *spec. nov.* Plate xi., fig. 2.

Shell ovate-oblong, moderately convex, inequilateral; umbones anterior; rounded in front, expanded, flattened, and obliquely truncated behind. Surface closely and irregularly concentrically folded, folds narrow, about as wide as the furrows, acutely rounded, minutely and regularly radially striated; the broad posterior flattened area is faintly marked by a median ridge, the lamellæ of growth in the form of thin imbricating plates. Lunule impressed lanceolate. Hinge area narrow; left valve with two cardinal teeth in front of the cartilage pit, and one lamellar tooth posteriorly; right valve with three cardinal teeth in front of the pit, the middle one very thick and crenulated on the side, the outer one small and marginal. Inner margin of valves denticulated.

Dimensions.—Length, 57; width, 37; thickness through both valves, 32 millimetres.

Locality.—Not rare Muddy Creek, Hamilton (*J. Dennant*).

This species, which is named after J. Dennant, Esq., Hamilton, in recognition of palæontological services rendered, has no immediate ally in recent creation, but it has some general resemblance to *C. Traillii*, Hutton, of the Older Tertiary of New Zealand, from which it differs by its truncated posterior margin and its concentric folds.

Crassatella aphrodina, Tenison-Woods.

Reference.—Proc. Roy. Soc., Tasm., for 1875, t. iii., fig. 12, p. 24.

"Ovate-trigonal, oblique solid, faintly striate and sulcate; umbones sharp, with more distinct sulci; lunule impressed; posterior side subangulate and produced. Long., 53; lat., 44 mills."

Localities.—Table Cape; Adelaide bore (fragments of hinge).

This species is related to *C. australis*, Hutton, of the New Zealand Tertiary.

Crassatella astartiformis, *spec. nov.* Pl. xi., figs. 12 and 15.

Shell subquadrate, slightly convex; umbones a little anterior; dorsal margin rather straight; posterior side roundly truncated, anterior side convex. Surface ornamented with concentric folds and minute, radial striæ; the folds are compressed, somewhat reflected, narrower than the furrows, more regular and stouter in the umbonal region.

Dimensions of a very large specimen:—Length, 20; width, 17; thickness through both valves, 8 millimetres.

Localities.—Very abundant of small size, Aldinga and Adelaide bore; rare, R. Murray Cliffs; Muddy Creek and Schnapper Point (*R.T.*).

Crassatella corrugata, *spec. nov.* Pl. ii., fig. 14.

Shell subquadrate, similar to *C. astartiformis*, but proportionately longer; surface with a few high angular corrugations, and striated between.

Dimensions.—Length, 6; width, 4·5 millimetres.

Locality.—Clays with *Turritella Aldingæ* at Blanche Point, Aldinga Bay.

Crassatella abbreviata, *spec. nov.* Pl. xi., fig. 16.

Shell subtriangular, elevated, compressed, inequilateral; umbones anterior, prominent; dorsal margin much sloped; anterior side very short; posterior margin roundly truncated. Surface ornamented with numerous narrow concentric folds. Inner margin of valves plain.

Dimensions.—Length, 8·5; width, 7·5; thickness through both valves, 3 millimetres.

Locality.—Calciferous sandstones, R. Murray Cliffs, near Morgan.

FAMILY ASTARTIDÆ.

Genus Micromeris, *Conrad.*

SYNOPSIS OF SPECIES.

Ornament of fimbriated, imbricating lamellæ.	*M. rugosa.*
Ornament of radial ridges and simple folds.	*M. radiata.*

Micromeris rugosa, *spec. nov.* Plate x., fig. 11.

Shell trigonal, compressed, with produced somewhat attenuated rather straight umbones, equilateral; anterior and posterior slopes straight, inclined at an acute angle; ventral margin rounded; inner margin of valves distantly crenulated. Lunule narrow, not deeply impressed. Surface crowded with thin imbricating lamellæ; the edges of the lamellæ varying from simple to thickly fimbriated, the fimbriations corresponding with rounded depressed radial riblets.

Dimensions.—Length, 3; width, 3·5 millimetres.

Locality.—Lower beds, Adelaide bore.

Micromeris radiata, *spec. nov.* Plate x., fig. 12.

Shell trigonal, slightly convex, with produced rather straight umbones, equilateral, ventrally rounded; inner margin of valves distantly crenulated. Surface smooth, shining, radially ribbed, and concentrically ridged or coarsely striated. Umbones in contact, bounded before and behind by a deep elliptical depression, angulated on the margin.

Dimensions.—Length, 4·5; width, 4·5; thickness through both valves, 2·5 millimetres.

Localities.—Very common in the lower beds, Blanche Point, Aldinga Bay, and Adelaide bore.

Gouldia lamellata, *spec. nov.* Plate ii., fig. 17.

Shell subtriangular to subquadrangular, compressed or moderately convex; umbones anterior, rather elevated and acute. Surface with about twenty thin, elevated, concentric lamellæ, and striæ of growth. Inner margin of valves with large, close crenulations. The shell differs in shape, in the amount of compression, and in the number of the lamellar folds; but one set of characters is not correlative with another set, so that the variations are individual, and not specific. The subquadrangular forms have a close resemblance to a *Chione*, allied to *Venus Allporti*, T. Woods, occurring in the same beds.

Dimensions.—Length, 5·5; width, 5 millimetres.

Localities.—Not uncommon in the lowest beds, Blanche Point, Aldinga, and Adelaide bore.

Genus Mytilicardia.

SYNOPSIS OF SPECIES.

Posterior side widened; ribs 21.	*M. alata.*
Posterior side narrowed; ribs narrow, 15.	*M. compta.*
Posterior side narrowed; ribs broad, 12.	*M. platycostata.*
Shell trapeziform, uniformly ribbed.	*M. curta.*

Mytilicardia alata, *spec. nov.* Plate ii., fig. 12.

Shell ovately-oblong, somewhat depressed; anterior side very short, truncated; widely rounded and compressed posteriorly; ventral margin nearly straight, inconspicuously sinuated.

Surface radially ribbed, with lamellar or spiny projecting scales, and undulating concentric lines of growth. Four ribs of large dimensions occupy the ridge extending from the umbo to the post-ventral angle; these are broad, rounded, not much elevated, rather abruptly narrowed to form a surmounting rib, which carries the distant spiny scales. The anterior ribs are twelve in number, densely covered with scaly spines. The posterior ridge is succeeded by a broad space with two flat ribs, posterior to which are three compressed ribs with imbricating spinous scales. Inner margin of valves coarsely crenulate.

Dimensions.—Length, 25; greatest width, 20; width at umbo, 12 millimetres.

Locality.—Adelaide bore.

This species is distinguished from *M. crassicostata*, and allied species possessing lamellar scales on the ribs, especially by its wing-like posterior slope; in the longitudinal constriction of the primary ribs it resembles *M. Novæ Hollandiæ*, Deshayes.

Mytilicardia compta, *spec. nov.* Plate xii., fig. 2.

Shell elongately ovate, somewhat depressed; ventral margin inconspicuously sinuated, in other respects similar to *M. crassicostata*, Lamk. There are four primary subangulated ribs, posterior to which are two narrow ribs succeeded by two compressed elevated ribs; the anterior ribs are seven in number. All the ribs are more or less raised into lamellar scales.

Dimensions.—Length, 29; greatest width, 17; width at umbo, 12 millimetres.

Localities.—Muddy Creek; oyster banks at North-west Bend Head Station, on the River Murray.

This species differs from *M. crassicostata* by its narrower shape, depressed umbones, and subacute ridges, and by the absence of a subanterior contraction ventrally.

Mytilicardia platycostata, R. M. Johnston.

Reference.—Proc. Roy. Soc. Tasm. for 1879, p. 40.

"Shell oblong ovate, ornamented with twelve broad slightly-raised squamose radiating ribs, surmounted by a smaller ridge of distant lamellose spines; breadth of interspaces and rays equal; rays finer and closer together as they approach the slope. Long., 50 mil.; lat., 35 mil.; alt. (both valves), 26 mil. Rare, Table Cape." R. M. Johnston.

Mytilicardia curta, *spec. nov.* Pl. ii., fig. 9.

Shell trapeziform, anteriorly very short, extremely gibbous; ventral margin straight, with a slight insinuation anteriorly; posterior margin roundly truncated; roundly elevated diagonally from the umbo, the posterior and dorsal portion somewhat dilated and convex; the ventral side is comparatively narrow and precipitous. Surface ornamented with 22 narrow, rather compressed, scaly, radial ribs; interstitial spaces slightly narrower than the ribs, marked with regular transverse liræ; margin of valves coarsely crenulated.

Dimensions.—Length, 13; greatest width towards the posterior margin, 11; width through the umbo, 8; thickness through both valves, 11 millimetres.

Locality.—Adelaide bore.

This species, which has a general resemblance to *Cardita trapezia*, Bruguiere, makes through *C. scabrosa*, mihi, an approach to the genus *Cardita*.

Genus Cardita.

SYNOPSIS OF SPECIES.

Triangular; ribs, 15, granose. *C. trigonalis.*
Ovate-triangular; ribs, 22, thin. *C. pecten.*
Rotund; ribs, 24, granose, linear interspaces. *C. compacta.*
Ovate-quadrate; ribs, 20, thick, crenulated. *C. Murrayana.*
Oval-subquadrate; ribs, 30, with erect scales. *C. scabrosa.*
Rotundly heart-shaped; ribs, 22, spinosely serrated. *C. spinulosa.*
Roundly oblong; ribs, about 30, with lamellar scales. *C. gracilicostata.*
id., widened posteriorly. *C. latissima.*
id., narrowed anteriorly; ribs, 37. *C. polynema.*
Roundly oblong; ribs, less than 30, with granulations.
Ribs, 26; fine granulations. *C. delicatula.*
Ribs, 22; coarse granulations. *C. Tasmanica.*

Cardita trigonalis, *spec. nov.* Pl. ii., fig. 1.

Shell triangular, moderately convex; umbones elevated, slightly oblique, incurved, anterior; posterior margin inclined, making with the slightly arched ventral margin a roundly acute angle; anterior side rounded; dorsally excavated. Surface ornamented with 15 crenately-nodulose, rounded, radiating ribs, the interspaces wider than the ribs with transverse thick liræ. Inner margin of valves coarsely crenulated.

Dimensions.—Length, 7; width, 6·5 millimetres.

Locality.—Oyster banks, Blanche Point, Aldinga Bay.

Cardita pecten, *spec. nov.* Plate ii., fig. 11.

Shell ovately triangular, transverse, rather depressed, regularly convex, except the flattened posterior slope; umbones small, acute, antemedian, directed forwards; anterior margin rounded, posterior obliquely truncated. Inner margin of valves coarsely crenulated. Surface ornamented with 22 narrow, compressed, crenately-granose, radial ribs; interspaces flat, wider than the ribs.

Dimensions.—Length, 6·5; width, 2; length from umbo to posterior angle, 6·5; thickness through both valves, 3 millimetres.

Localities.—Muddy Creek; Oyster-beds, North-West Bend of the River Murray.

Cardita compacta, *spec. nov.* Plate ii., fig. 13.

Shell minute, rotund, subglobose, subequilateral; umbones prominent, obtuse, incurved, approximate. Surface ornamented with 24 crenately-granose ribs separated by linear interspaces. Inner margin of valves crenately-serrated.

Dimensions.—Length, 5; width, 4·5; thickness through both valves, 3·5 millimetres,

Locality.—Muddy Creek.

This little shell resembles in ornamentation *C. scalaris*, Sow., recent north-west coast of America, and fossil in the English Crags; and *C. amabilis*, Deshayes, living off the coast of Tasmania, from both of which it differs in shape. It has some affinity to *C. parva*, Lea of the Claiborne-Eocene.

Cardita Murrayana, *spec. nov.* Plate ii., fig. 2.

Shell ovate-quadrate, moderately inflated, inequilateral; umbo anterior, broad, oblique, incurved; posterior side produced and flattened; radiately ribbed. Ribs 20, broad, rounded, elevated, crenulated; interspaces concave, about as wide as the ribs.

Dimensions.—Length, 35; width, 29; thickness through both

valves, 26; length of anterior side, 8; from umbo to post-ventral angle, 35 millimetres.

Locality.—Calciferous sandstone, Glenforslan, near Blanchetown, on the River Murray.

This species has some affinity to *C. spinulosa*, but is more produced and less inflated, and has a different ornament; among recent species it has the shape and number of ribs of *C. angisulcata*, Reeve, but in that shell the ribs are flat, broad, and close together.

Cardita scabrosa, *spec. nov.* Pl. ii., fig. 4.

Shell oval-subquadrate, anterior side very short, moderately convex; umbones anterior, incurved; posterior margin abruptly truncated; posterior side slightly dilated and flattened; inner margin of valves coarsely crenulated. Surface ornamented with 30 narrow compressed radial ribs, about as wide, or not quite so wide, as the interspaces; ribs densely covered with erect scales, which are somewhat spathulate, except on the posterior slope where they are somewhat oblong.

Dimensions.—Length, 21; width, 16; thickness through both valves, 12 millimetres.

Localities.—Calciferous sandrock of the River Murray Cliffs, near Morgan; Muddy Creek; Corio Bay.

Cardita gracilicostata, Tenison-Woods. Pl. ii., figs. 6 and 8.

Reference.—Proc. Roy. Soc., Tasm., for 1876, p. 112 (1877).

Shell roundly-oblong, transverse, inequilateral, moderately inflated; umbones anterior, oblique, much incurved. Surface ornamented with transverse raised liræ, and about 30 curved, radiating ribs, narrower than the concave interspaces; the ribs are laterally compressed, obsoletely nodular in the adult, except the anterior and posterior slopes, where the nodulations become less rounded and more lamellose. In young shells the ribs are densely beset with thick imbricating scales, somewhat spinous on the posterior slope, and granulose on the anterior side; minutely granular in the interspaces. Inner margin of valves coarsely crenulated; lunule short cordate, well defined and deep.

Dimensions of a large specimen:—Length, 35; of posterior side, 25; width, 31; thickness through both valves, 20 millimetres.

Locality.—Table Cape, Tasmania! (*R. M. Johnston*).

Of the many recent and fossil species with which I have compared *C. gracilicostata*, *C. acuticostata*, Lamarck, of the Anglo-Parisian Eocene basin, is the only one to which it bears any resemblance; from that species it differs in being less orbicular and in its simple ribs.

Cardita latissima, *spec.nov.* Pl. x., fig. 5.

Shell quadrately orbicular, very inequilateral, inflated; umbones near the front, oblique, incurved; anterior side short, rounded; acutely-roundly truncated and compressed posteriorly; ventral margin regularly arched. Surface with about 30 fine laterally compressed scaly ribs, much narrower than the flattish transversely striated interspaces. The ribs are densely beset with erect lamellar scales, becoming somewhat spinous on the posterior slope and thick on the anterior area. Lunule short, cordate, shallow; inner margin of valves coarsely crenulated.

In very young shells the ribs are much fewer, granulated, but spinose on the posterior slope.

Dimensions.—Length, 31; of posterior side, 23; width, 29; thickness through both valves, 20 millimetres.

Localities.—Very abundant Adelaide bore, and Blanche Point, Aldinga Bay.

This species in its ornamentation is similar to the young of *C. gracilicostata*, but the shape is very different; it is less globose than the recent *C. abyssicola*, Hinds, but the sculpture is different.

Cardita spinulosa, *spec. nov.* Pl. ii., fig. 3.

Shell rotundately heart-shaped, inflated, inequilateral; umbo anterior, oblique, incurved; radiately ribbed. Ribs, 22; spinosely serrated, very narrow, laterally compressed; interspaces wide, densely and irregularly lamellosely wrinkled; in the umbonal region the interspaces and the ribs are minutely granular. Inner margin of valves coarsely crenulated.

Dimensions.—Length, 33; width, 31; length of anterior side, 9; thickness through both valves, 36 millimetres.

Locality.—Blue clays, Schnapper Point, Hobson's Bay.

Cardita polynema, *spec. nov.* Plate ii., fig. 7.

Shell roundly-oblong, transverse, moderately inflated; umbones anterior, oblique, incurved; anterior side very short.

Surface ornamented with 37 narrow compressed radial ribs, about as wide as the interspaces; ribs densely covered with erect oval scales, except on the posterior and anterior slopes where they are somewhat spinous.

Dimensions.—Length, 18; width, 15·5; thickness through both valves, 11 millimetres.

Locality.—Schnapper Point, Port Phillip.

This species agrees in shape with *C. gracilicostata*, though less produced anteriorly, but has more numerous and closer ribs; it is somewhat intermediate between that species and *C. scabrosa.*

Cardita delicatula, *spec. nov.* Plate ii., fig. 10.

Shell roundly-oblong, rather depressed; umbones anterior oblique, incurved; posterior margin roundly truncated.

Surface ornamented with 26 compressed radial ribs, densely beset with granules passing into scales on the posterior slope; interspaces a little wider than the ribs. Inner margins of valves coarsely crenulated.

Dimensions.—Length, 11; width, 10; thickness through both valves, 6 millimetres.

Localities.—Common in the calciferous sandrock of the River Murray Cliffs, near Morgan; Muddy Creek; Schnapper Point

With the general form of *C. gracilicostata* this species is distinguished by its fewer and granular ribs.

Cardita Tasmanica, *spec. nov.* Plate xii., fig. 13.

Shell thick, roundly oblong, rather depressed; umbones prominent, oblique, incurved; anterior side very short.

Surface ornamented with 22 thickish, elevated, densely crenately-nodose, radiating ribs; interspaces a little wider than ribs, moderately concave, transversely wrinkled. Inner margin of valves coarsely crenulated.

Dimensions.—Length, 16; width, 14; thickness through both valves, 9 millimetres.

Locality.—Table Cape! (*R. M. Johnston*).

This species comes very near *C. delicatula*, but it has fewer ribs, which are thicker and coarsely ornamented; it has much resemblance to *C. rotunda*, Lea. of the Claiborne-Eocene, but that species has thin, elevated, scaly ribs.

Explanation of Plates.

N.B.—The figures are of the natural sizes, except when otherwise stated.

Plate II.

1. Cardita trigonalis, *Tate.* Enlarged.
2. Cardita Murrayana, *Tate.*
3. Cardita spinulosa, *Tate.*
4. Cardita scabrosa, *Tate.* R. Murray Cliffs.
5. Cardita latissima, *Tate.*
6. Cardita gracilicostata, *T. Woods.*
7. Cardita polynema, *Tate.*
8. Cardita gracilicostata, *T. Woods.* A young example.
9. Mytilicardia curta, *Tate.*
10. Cardita delicatula, *Tate.* R. Murray Cliffs.
11. Cardita pecten, *Tate.* Enlarged. Muddy Creek.
12. Mytilicardia alata, *Tate.*
13. Cardita compacta, *Tate.*

14. Crassatella corrugata, *Tate.* Enlarged.
15. Barbatia consutilis, *Tate.*
16. Barbatia crustata, *Tate.* Enlarged.
17. Gouldia lamellata, *Tate.* Much enlarged.

Plate III.

1. Lima linguliformis, *Tate.* Muddy Creek. *a*, Natural size; *b*, magnified portion near the front.
2. Pecten subbifrons, *Tate.* Adelaide.
3. Vulsella lævigata, *Tate.* *a*, Exterior view, natural size; *b*, hinge-line, enlarged.
4. Modiolaria Corioensis, *Tate.* Much enlarged.
5. Modiolaria subgranosa, *Tate.* Much enlarged.
6. Pecten consobrinus, *Tate.* Aldinga.
7. Modiolaria singularis, *Tate.* Much enlarged.
8. Limea alticostata, *Tate.* Much enlarged.
9. Dimya dissimilis, *Tate.* Slightly enlarged. Muddy Creek. *a*, Exterior view of attached valve; *b*, interior view of the same; *c*, exterior of free valve.

Plate IV.

1. Ostrea hippopus, *Tate.* *a*, View from above; *b*, side view.
2. Nucula Morundiana, *Tate.* *a*, End view; *b*, seen from above; both enlarged; *c*, magnified view of surface.
3. Nucula Atkinsoni, *R. M. Johnston.* River Murray Cliffs. *a*, View from above; *b*, end view; both natural sizes; *c*, magnified view of surface.
4. Nucula fenestralis, *Tate.* Much enlarged.
5. Nucula semistriata, *Tate.* *a* and *b*, Much enlarged views.
6. Pecten spondyloides, *Tate.* A small example. Aldinga Cliffs.
7. Pecten spondyloides. Variety from Mannum.
8. Lima (Limatula) Jeffreysiana, *Tate.* River Murray Cliffs.

Plate V.

1. Placunanomia sella, *Tate.* River Murray Cliffs. *a*, Attached valve; *b*, exterior view of foramen with the shell broken away, showing the margin of the plug-sheath; *c*, interior view, showing plug-sheath.
2. Leda planiuscula, *Tate.* Natural size in outline, and much enlarged view.
3. Leda obolella, *Tate.* Natural size in outline; *a* and *b*, exterior and umbonal aspect, enlarged. Muddy Creek.
4. Pecten palmipes, *Tate.* Left valve. Edithburg.
5. Leda crebricostata, *T. Woods.* Natural size in outline; *a* and *b*, exterior and umbonal aspect, much enlarged.

6. Leda acinaciformis, *Tate.* Natural size in outline; *a* and *b*, exterior and umbonal aspects, enlarged.
7. Placunanomia Ione, *Gray.* 7*a*, Interior view of free valve; *a*, the cartilage furrow; *b*, muscular impression; *c*, adductor impression; 7*b*, exterior view of free valve.
8. Lima Bassii, *T. Woods.* River Murray Cliffs. *a*, Natural size; *b*, enlarged view of ornament.

Plate VI.

1. Ostrea Sturtiana, *Tate.* Overland Corner.
2. Gryphæa tarda, *Hutton.* *a*, Side view of attached valve; *b*, free valve seen from above. Great Australian Bight.
3. Rhynchonella Baileyana, *Tate.* *a*, Seen from above; *b*, front view; *c*, side view.
4. Leda Huttoni, *T. Woods.* Aldinga.
5. Ostrea hyotis, *Linn.* Blanchetown.
6. Nucula tumida, *T. Woods.* *a* and *b*, Front and side views. Muddy Creek.
7. Leda lucida, *T. Woods.* *a* and *b*, Front and umbonal aspects of an adult example. Near Morgan.

Plate VII.

1. Pecten Aldingensis, *Tate.* *a* and *b*, Right and left valves; *c*, ornamentation much enlarged.
2. Pecten Sturtianus, *Tate.* *a* and *b*, Left and right valves; *c*, ornamentation much enlarged. R. Murray Cliffs.
3. Pecten Zitteli, *Hutton.* *a*, Right valve; *b*, left valve; *c*, interior of left valve; enlarged views. Muddy Creek.
4. Pecten palmipes, *Tate.* *a*, Right valve; *b*, enlarged view of an interstitial space.
5. Pecten Murrayanus, *Tate*, *a* and *b*, Right and left valves. R. Murray Cliffs.

Plate VIII.

1. Lima Bassii, *T. Woods.* *var.* Adelaide bore. *a*, nat. size; *b*, Hinge area enlarged; *c*, magnified ornament.
2. Pecten polymorphoides, *Zittel.* R. Murray Cliffs.
3. Pecten Eyrei, *Tate.* Aldinga.
4. Lima polyactina, *Tate.* *a* and *c*, Interior and exterior views, enlarged; *b*, magnified portion of exterior.
5. Limarca angustifrons, *Tate.* *a*, Exterior enlarged; *b*, hinge area much enlarged.
6. Pecten Eyrei, *Tate.* Scaly ornament of, slightly enlarged.
7. Pecten Flindersi, *Tate.* *var.* Aldinga.
8. Dimya sigillata, *Tate.* *a*, Interior; *b*, exterior of attached valve, enlarged.

Plate IX.

1. Septifer fenestratus, *Tate.*
2. Modiolaria arcacea, *Tate.*
3. Pecten dichotomalis, *Tate.* *a* and *b*, Right and left valves; *c*, magnified view of portion of surface.
4. Leda apiculata, *Tate.* *a* and *b*, Enlarged views. Aldinga.
5. Anomia cymbula, *Tate.* Slightly enlarged.
6. Limea transenna, *Tate.* *a*, Enlarged; *b*, magnified ornamentation.
7. Pecten antiaustralis, *Tate.* *a*, Natural size; *b*, portion of surface near the front; *c*, in the umbonal region, magnified.
8. Leda Woodsii, *Tate.* Adult example enlarged.
9. Meleagrina crassicardia, *Tate.* Young example. Muddy Creek.
10. Meleagrina crassicardia, *Tate.* Cardinal area of an adult. North-West Bend of the River Murray.

Plate X.

1. Pecten Peroni, *Tate.* *a*, Natural size; *b*, sculpture, magnified. Aldinga.
2. Barbatia limatella, *Tate.* Adelaide.
3. Crenella globularis, *Tate.* *a* and *b*, Much enlarged. Adelaide.
4. Macrodon Cainozoicus, *Tate.* *a*, Natural size; *b*, enlarged hinge-line; *c*, magnified ornament. Muddy Creek.
5. Leda leptorhyncha, *Tate.* *a* and *b*, Enlarged views. Adelaide.
6. Ostrea arenicola, *Tate.* Aldinga.
7. Barbatia pumila, *Tate.* Slightly enlarged. Muddy Creek.
8. Petunculus Cainozoicus, *T. Woods* Variety from Muddy Creek; *a* and *b*, front and umbonal aspects.
9. Lima (Limatula) polynema, *Tate.* Slightly enlarged.
10. Barbatia celleporacea, *Tate.* *a* and *b*, Front and umbonal aspects. Schnapper Point.
11. Micromeris rugosa, *Tate.* Slightly enlarged. Adelaide.
12. Micromeris radiata, *Tate.* *a* and *b*, Front and umbonal aspects, enlarged.

Plate XI.

1. Pectunculus lenticularis, *Tate.* Adelaide.
2. Crassatella Dennanti, *Tate.* Muddy Creek.
3. Modiola Adelaidensis, *Tate.* Adelaide.
4. Barbatia dissimilis, *Tate.* Left valve, slightly enlarged. Adelaide bore.
5. Barbatia dissimilis, *Tate.* Right valve, slightly enlarged. Adelaide bore.

6. Petunculus subtrigonalis, *Tate.* *a* and *b*, Exterior and interior aspects. River Murray cliffs.
7. Petunculus convexus, *Tate.* *a* and *b*, Umbonal and front aspects. Muddy Creek.
8. Arca pseudonavicularis, *Tate.* *a* and *b*, Front and umbonal aspects. Adelaide bore.
9. Arca equidens, *Tate.* Much enlarged. Adelaide bore.
10. Barbatia simulans, *Tate.* Muddy Creek.
11. Avicula nasuta, *Tate.*
12. Crassatella astartiformis, *Tate.*
13. Trigonia tubulifera, *Tate.* *a*, Enlarged; *b*, magnified ornament. Muddy Creek.
14. Cucullæa Adelaidensis, *Tate.* *a*, Natural size; *b*, enlarged ornament.
15. Crassatella astartiformis, *Tate.* Young example.
16. Crassatella abbreviata, *Tate.* Slightly enlarged. River Murray cliffs.

Plate XII.

1. Limopsis multiradiata, *Tate.* *a*, Enlarged view of valve; *b*, surface near the front, magnified.
2. Mytilicardia compta, *Tate.* Muddy Creek.
3. Lucina dentata, *Wood.* North-West Bend.
4. Leda prælonga, *Tate.* *a* and *b*, Front and umbonal aspects, much enlarged. Muddy Creek.
5. Lucina fabuloides, *Tate.* Enlarged.
6. Lucina projecta, *Tate.* Muddy Creek.
7. Lucina leucomomorpha, *Tate.* *a* and *b*, Front and umbonal aspects. Muddy Creek.
8. Saxicava australis, *Lamarck.* Adelaide bore.
9. Pinna semicostata, *Tate.*
10. Lucina nuciformis, *Tate.* *a* and *b*, Front and umbonal aspects, much enlarged.
11. Lucina planatella, *Tate.* Table Cape.
12. Avicula nasuta, *Tate.* Fragment of right valve, with the anterior wing complete.
13. Cardita Tasmanica, *Tate.*
14. Cardium cuculloides, *Tate.* *a* and *b*, front and umbonal aspects. Muddy Creek.

MISCELLANEA.

———o———

The Dasyurus a (?) Vegetarian.

On Friday, January 30, 1885, I saw Mr. F. H. Edwards, lessee of the late Mr. George S. Kingston's estate at Marino, and he informed me (and Messrs. George Laughton and J. T. Fickling) that he had missed a great number of peaches from some of the trees in the garden, and, suspecting that opossums were destroying the fruit, he had some steel traps set beneath the trees. The next morning after setting them his sons brought in a native spotted cat (Dasyurus), which he (Mr. Edwards) opened and examined, and was surprised to find its maw filled with masticated peach-pulp. He afterwards examined others caught in the same manner, and always found the pulp in their stomachs. This being a new fact in natural history has been considered worthy of mention before this Society. The two gentlemen who were with me are intimate with Mr. Edwards, and vouch for the reliability of his statements.

A. Molineux.

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Fungi Collected by J. G. O. Tepper about Clarendon, 1882-3.

Identified by Dr. Cooke from specimens sent, viz:—

Agaricus sobrius, *Fries.*
" umbelliformis, *Fr.*
" spumosus, *Fr.*
" quilinus *Fr.*
" tener, *Fr.*
" pediades, *Fr.* (or nearly related species).
" faxiculatus.
Polyporus oblectans, *Berkeley.*
Secotium coarctatum, *Berk.*
Hygrophorus ceraceus, *Fries.*
Clavaria rugosa, *Fr.*
Dacrymyces, sp.

The above are addenda to a list published in the Society's Transactions, vol. vi., p. 68.

List of Plants Collected by Chas. Winnecke, near Stuart's Range in 1885.

By Baron von Mueller, K.C.M.G., M.D., Ph.D., F.R.S.

Ranunculus parviflorus, *Linné.*
Lepidium phlebopetalum, *F. v. M.*
" papillosum, *F. v. M.*
Zygophyllum fruticulosum, *Candolle.*
Plagianthus glomeratus, *Bentham.*
Frankenia lævis, *L.* (several varieties).
Polycnemum diandrum, *F. v. M.*
Ptilotus obovatus, *F. v. M.*
Pimelea simplex, *F. v. M.*
Loranthus pendulus, *Sieber.*
Aster Muelleri, *Sonder.*
Minuria leptophylla, *Candolle.*
Calotis plumulifera, *F. v. M.*
Ixiolæna leptolepis, *Bentham.*
Gnephosis arachnoidea, *Turczaninow.*
Chthonocephalus Pseudevax, *Steetz.*
Angianthus pusillus, *Bentham.*
Podolepis Siemsieni, *F. v. M.*
" canescens, *Cunningham.*
Helipterum pterochætum, *Bentham.*
" moschatum, *Bentham.*
" floribundum, *Candolle.*
" strictum, *Bentham.*
Isotoma petræa, *F. v. M.*
Plantago varia, *R. Brown.*
Nicotiana suaveolens, *Lehmann.*
Dæmia Kempeana, *F. v. M.*
Convolvulus erubescens, *Sims.*
Eremophila scoparia, *F. v. M.*
" Gilesii, *F. v. M.* (corolla blue).
" rotundifolia, *F. v. M.*
" Duttonii, *F. v. M.*
Triglochin centrocarpa, *Hooker.*
Stipa crinita. *Gaudichaud.*
Cheilanthes tenuifolia, *Swartz.*

On the Occurrence of Astrorhiza angulosa as a Fossil in the Older Tertiary of Victoria.

In January, 1885, Mr. Henry Watts, of Melbourne, sent me a series of fossil Foraminifera for identification. Among these was a slide containing several examples of the above species,

and is of some interest as being the first instance in which the genus has been obtained in a fossil condition. The genus was founded by Sandahl for a group of arenaceous Foraminifera built up of very fine sand grains, and takes the form of angular, radiating, or branching masses. *A. angulosa* is one of the deep-sea forms described by Mr. H. B. Brady from the Challenger dredgings. It appears to have a very limited distribution in existing seas. The last-named authority states that the figured specimens of his work "are all from station 78, east of Azores, from a depth of 1,000 fathoms, and except for a single example found in one of the Porcupine dredgings in the North Atlantic at 630 fathoms, this is the only locality at which the variety has been collected." The specimens under notice were found, I believe, at Waurn Ponds, near Geelong, and correspond exactly with the subtriangular specimens figured by Mr. Brady.

W. Howchin, *Ed.*

Australian Fossil Bryozoa.

Mr. A. W. Waters, F.G.S., has published two more valuable articles on the fossil Bryozoa of Australia since our last notice of his work in this department. In Quar. Jour. Geol. Soc., Nov., 1884, he deals with the Cyclostomatous group, and figures several new species from Aldinga, the Mount Gambier beds, and from the Tertiaries of the other colonies. Prof. Tate having sent a large series of Bryozoan remains to Mr. Waters, the result of extensive work in the Aldinga and Murray Cliff sections, and including a few from the Adelaide Government bore, Mr. Waters has described them in *loc. cit.*, Aug., 1885. The collection furnishes no less than 73 species, "of which," Mr. Waters states, "46 are known living, bringing the number of Australian fossil Bryozoa described up to 220, of which just about half have been found living." The former article is illustrated by two plates, and the latter by one.

The full list of species as determined by Mr. Waters from South Australian "Older Tertiary" material is as follows:—

1. Cellaria malvinensis, *Busk.*
2. " angustiloba, *B.*
3. Membranipora aperta, *Busk.*
4. " circularis, *d'Orb.*
5. " Savartii, *Aud.*
6. " radicifera, *Hincks.*
7. " rhynchota, *Busk.*
8. " temporaria, *spec. nov.*
9. " Flemingii, *Busk.*

10. Membranipora cylindriformis, *Waters*.
11. " parvicella, *T. Woods*.
12. " Michaudiana, *d'Orb*.
13. " trifolium, *var*.
14. Micropora patula, *Waters*.
15 " perforata, *MacG*.
16. Monoporella crassatina. *Waters*.
17. " sexangularis, *Goldf*.
18. Stenagoporella magnilabris, *Busk*.
19. " Rozieri, *var* indica, *H*.
20. Cribrilina radiata, *Moll*.
21. " figularis, *Johnst*.
22. " terminata, *Waters*.
23. Mucronella mucronata, *Sm*.
24. " nitida, *Verrill*.
25. " coccinea, *var*. mamillata, *B*.
26. " coccinea, *var*. resupinata, *Manz*.
27. Microporella grisea, *Lamx*.
28. " coscinopora, *var*. armata, *W*.
29. " violacea, *Johnst*., *var*. fissa, *W*.
30. " symmetrica, *Waters*.
31. " ferrea, *Waters*.
32. " pocilliformis, *sp. nov*.
33. " (Lunulites) magna, *Woods*.
34. " magnirostris, *MacG*.
35. " elevata, *Woods*.
36. Porina coronata, *Rss*.
37. Lepralia edax, *Busk*.
38. " depressa, *Busk*, *var*. *W*.
39. " rostrigera, *Sm*.
40. " escharella, *Römer*.
41. " burlingtoniensis, *Waters*.
42. " subimmersa, *MacG*.
43. " confinita, *sp. nov*.
44. Smittia Tatei, *T. Woods*.
45. " Landsborovii, *Johnst*.
46. " reticulata, *MacG*.
47. " seriata, *Rss*.
48. " Milneana, *B*., *var*. coæquata, *W*.
49. Schizoporella vulgaris, *Moll*.
50. " simplex, *J*., *var*.
51. " phymatopora, *Rss*.
52. " striatula, *Sm*.
53. " fenestrata, *Waters*.
54. " Cecilii, *Aud*.
55. " protensa, *sp. nov*.
56. Mastigophora Dutertrei, *Aud*.

57. Retepora marsupiata, *Sm.*
58. Rhynchopora bispinosa, *Johnst.*
59. Cellepora coronopus, *Busk.*
60. " avicularis, *Hincks.*
61. " costata, *MacG.*
62. " divisa, *sp. nov.*
63. " mamillata, *Busk.*
64. " albirostris, *Sm.*
65. " pertusa, *Sm.*
66. " " *var.* ligulata, *nov.*
67. " biradiata, *sp. nov.*
68. " tridenticulata, *Busk.*
69. " fossa, *Haswell.*
70. " " *var.* marsupiata, *nov.*
71. Lekythopora hystrix, *MacG.*
72. Cupularia Canariensis, *Busk.*
73. Selenaria maculata, *Busk.*

W. Howchin, *Ed.*

Notes on Some Mesozoic Plant-Remains from South Australia. By Henry Woodward, LL.D., F.R.S., F.G.S., &c., (*Geological Magazine, July*, 1885.)

Fossils from Mount Babbage consist of plant remains almost entirely converted into a pure quartzite, and include—

(1) A fragment of a small stem considered to belong to the Cycadeæ and named *Mantellia Babbagensis* (Pl. vii., fig. 1-2).

(2) And a badly preserved specimen of *Clathraria* or *Bucklandia* of the Cycadeæ, but which Mr. W. Carruthers, F.R.S., considers a fragment of silicified wood bored into by Teredoes (Pl. vii., fig. 6).

Fossils from Cutaway Hill, Leigh Creek; these consist of impressions of strap-like leaves and slender stalks of some vegetable on a block of quartzite, but do not afford sufficient evidence for exact determination.

Fossil from Mount Adams consists of a quartzite with an impression of a palmate leaf (woodcut), suggestive of the leaf of a *Salisburia.*

The localities of the fossils are mapped as Mesozoic by the Government Geologist, from whom the specimens were received.

R. Tate.

ABSTRACT OF PROCEEDINGS

OF THE

Royal Society of South Australia,

FOR 1884-1885.

ORDINARY MEETING, NOVEMBER 4, 1884.

Professor LAMB in the chair.

BALLOT.—A. A. Lendon, M.D.; John Gosse, M.R.C.S., were elected Fellows; and J. J. East a Corresponding Member.

EXHIBITS.—Mr. Molineux exhibited some insects sent from Kangaroo Island by W. J. Horswill.

Mr. J. J. EAST forwarded a paper on a geological section from the head of St. Vincent Gulf eastward across the basins of the Rivers Wakefield and Light, which was read.

Professor TATE forwarded Remarks on some recent papers upon the "Palæontology of South Australia," which was read.

Mr. F. S. CRAWFORD gave a paper upon the "Shot-hole Disease in Apricot, Almond, and Peach Trees."

ORDINARY MEETING, DECEMBER 2, 1885.

Professor LAMB in the chair.

EXHIBITS.—The skin of *Grallaria pratincola* by Mr. R. H. Pulleine. A caterpillar preserved in glycerine by Mr. Pickels. Mr. Mestayer pointed out that a solution of chloral-hydrate was good for preserving such specimens; and Mr. Tepper remarked that one per cent. of chromic acid added to the glycerine was effectual to prevent softening and shrinkage. Mr. J. W. Jones, Conservator of Water, forwarded portions of the core from the bore at Hergott Springs.

Mr. W. HOWCHIN, F.G.S., read a paper on "Some Fossil Foraminifera found in the Government boring at Hergott, with general remarks on the Section and on other forms of Microzoa observed therein."

Ordinary Meeting, February 5, 1885.

Dr. Whittell in the chair.

Ballot.—Mr. W. A. Jones was elected a Fellow.

Exhibits.—Dr. Cleland showed some fragments of coral found on the surface of a plain fifteen miles north-west of Farina. In reference to this, Mr. Howchin stated that he had been informed by the Conservator of Water that fossils which he (the Conservator of Water) believed to be of Cretaceous age were found close to the surface in that locality, whilst calcareous casts were met with in the boring made in the neighbourhood. A stone showing casts of various molluscs from the bore at Hergott was shown. Dr. Mayo exhibited a lizard (*Œdura rhombifera*), commonly known as the Australian Gecko; also a specimen of *Lactuca saligna*.

Mr. F. H. Edwards, of Marino, wrote, saying that he had trapped some native spotted cats (*Dasyurus*), in the stomachs of which he had found peaches.

A paper by F. W. Andrews was read on the "Nidiology of the *Leipoa ocellata*."

Mr. Tepper showed a new variety of Drosera.

Mr. S. Dixon read a paper on "Some Native South Australian Plants suitable for Cultivation as Fodder."

Mr. Tepper read a paper "On some New and Rare Insects."

Ordinary Meeting, March 3, 1885.

Prof. Lamb in the chair.

Ballot.—Prof. Rennie was elected a Fellow.

Prof. Lamb read a paper on the "Persistency of Electrical Currents in Masses of Iron;" also a paper on the "Cause of Luminosity in Flame."

Prof. Rennie read some remarks on the cause of "Discoloration Observed in certain South Australian Bricks."

Ordinary Meeting, April 14, 1885.

Prof. Lamb in the chair.

Exhibits.—Dr. Stirling exhibited and explained a number of instruments for conducting physiological observations.

Dr. Haacke made observations respecting "Two Remarkable Species of South Australian Fishes;" also concerning "South Australian Rays and Sharks, with special reference to the gravid uterus of the former;" also on the "Colour of Deep-sea Crabs, Boiled Crayfish, and Hermit Crabs;" and "On the gravid uterus of some South Australian Lizards."

Ordinary Meeting, May 5, 1885.

Professor Lamb in the chair.

Ballot.—Mr. Thomas Gill was elected a Fellow.

Exhibits.—Dr. Mayo exhibited a specimen of beetle belonging to the species *Schizorrhina*. Mr. Tepper laid on the table a piece of limestone with regular ovate enclosures. Specimens mounted on glass and immersed in spirit, and prepared by a special method of Mr. Zietz, the *preparateur* at the Museum, were shown. They included one of the *Cyanidæ*, an annelide thickly covered with fine long tentacles, a specimen of *Cydippe pileus*, of *Eudendrium rameum*, of *Limax variegatus*, of *Triton tæniatus* (male and female), and two specimens of *Gecko*. All the exhibits presented a very natural appearance.

Mr. A. W. Jones read a paper upon "Iridiscent Clouds."

Ordinary Meeting, June 2, 1885.

Professor Lamb in the chair.

Ballot.—Mr. W. Ernest Cooke, B.A., was elected a Fellow.

Exhibits.—Mr. Howchin showed a piece of hydratid oxide of iron from Alice Springs, which had been mistaken for a meteorite. Dr. Whittell exhibited and explained the use of a new and simple freezing microtome.

Mr. Howchin made some remarks upon a specimen of *Astrorhiza angulosa* sent over from Victoria by Mr. Watts, and found by him in the Miocene beds of that colony.

Mr. Wragge read a paper on some "Observations made by him during the voyage of the s.s. Maranoa to this colony from England."

Ordinary Meeting, July 7, 1885.

Professor Lamb in the chair.

Ballot.—Mr. R. B. Lucas was elected a Fellow.

Mr. Gavin Scoular forwarded a paper on "Past Climatic Changes in South Australia, with reference to a Glacial Period," which was partly read.

Ordinary Meeting, August 4th, 1885.

Dr. Whittell in the chair.

Ballot.—Dr. Renner was elected a Fellow.

Exhibits.—Mr. Tepper brought an Orchid collected at Cape Willoughby by Mr. J. Horswill, apparently new. He also read a list of fungi collected by him in the neighbourhood of Clarendon.

The remaining portion of Mr. Scoular's paper was read.

A criticism on some portions of Mr. Scoular's argument was forwarded by Prof. Tate and read.

Ordinary Meeting, September 8th, 1885.

Mr. W. Rutt, C.E., in the chair.

Mr. Geo. Styles, of Port Caroline, wrote respecting cyclones, and their tendency to blow towards a centre, and suggested that fuller meteorological observations should be published, so that the advent of storms might be ascertained.

Mr. W. Ernest Cooke, B.A., made some critical remarks in reply, showing that it was by no means an easy thing to forecast the weather, even with the help of the telegraph.

Mr. Bednall forwarded a description of species of *Murex* and *Typhis*, of the coast of South Australia.

Mr. E. Guest sent a paper on the "Nomenclature and Description of some South Australian Butterflies."

The unclassified results of a dredging expedition in St. Vincent Gulf were laid on the table.

Annual Meeting, October 6th, 1885.

Dr. Whittell in the chair.

Mr. L. C. E. Gee was appointed to audit the accounts.

By-laws for the admission of bodies of science-workers, and for their government as Sections of the Royal Society of South Australia, were read, discussed, amended, and adopted.

Exhibits.—Mr. Tepper showed a very large cocoon densely packed with silk, which he had found in a mallee-log. The insect producing it was unknown.

The annual report was then read, as follows:—

ANNUAL REPORT.

The Council has the honour of reporting that the following papers have been laid before it:—"Geological Section from the head of St. Vincent Gulf eastward across the Wakefield and Light River Basins," by J. J. East; "Remarks on Recent Papers upon the Palæontology of South Australia," by Prof. Tate, F.G.S.; "Shothole Disease in Apricot, Almond, and Peach Trees," by F. S. Crawford; "Some Foraminifera Found in the Boring at Hergott Township," by W. Howchin, F.G.S.; "The Nidiology of the *Leipoa ocellata*," by F. W. Andrews; "Some Native South Australian Plants suitable for Cultivation as Fodder," by S. Dixon; "Notes upon New and Rare Insects," by J. G. O. Tepper, F.L.S.; "The Persistency of Electrical Currents in Masses of Iron," by Prof. Lamb, F.R.S.; "The Cause of Luminosity in Flame," by Prof. Lamb, F.R.S.; "Notes on Discolouration Observed in certain Bricks," by Prof. Rennie, D.Sc.; "Two Remarkable Species of South Australian Fishes," by W. L. Haacke, Ph.D.; "Observations respecting South Australian Rays and Sharks, with special

reference to the gravid uterus of the former," by W. L. Haacke, Ph.D.; "On the Colour of Deep-sea Crabs, Boiled Crayfish, and Hermit Crabs," by W. L. Haacke, Ph.D.; "Observations respecting the gravid uterus of some South Australian Lizards," by W. L. Haacke, Ph.D.; "Iridescent Clouds," by W. A. Jones; "Scientific Observations made during the Voyage of the steamer Maranoa from England to South Australia," by C. L. Wragge, F.R.G.S.; "Past Climatic Changes in South Australia, with special reference to a Glacial Period," by Gavin Scoular; "Concerning a Glacial Epoch in South Australia," by Prof. Tate, F.G.S.; "Some Meteorological Observations," by Geo. Styles; "Respecting the Possibility of Forecasting the Weather in South Australia," by W. Ernest Cooke, B.A.; "Description of the Species *Murex* and *Typhis* of the Coast of South Australia," by W. Bednall; "Nomenclature and Description of some South Australian Butterflies," by E. Guest; "The Palliobranchs of the Older Tertiaries," by Prof. Tate, F.G.S.; "The Lamellibranchs of the Older Tertiaries," by Prof. Tate, F.G.S.; "Additions to the Flora of South Australia," by Prof. Tate, F.G.S.

The financial statement was made, and showed that the receipts during the year had been £253 4s. 4d., and the expenditure £201 1s. 11d. The balance at the Bank was £117 2s. 2d., and £250 was placed on deposit. The report and balance-sheet were adopted.

Election of Officers.—President, H. C. Mais, M.I.C.E; Vice-Presidents, W. Howchin, F.G.S., and R. L. Mestayer, C.E.; Hon. Treasurer, Walter Rutt, C.E.; Hon. Secretary, W. L. Cleland, M.B.; Council, Professor Rennie, H. T. Whittell, M.D., E. C. Stirling, M.D., J. W. Bussell, D. B. Adamson, W. E. Cooke, B.A.

The following papers by Professor Tate were laid on the table and taken as read:—"The Palliobranchs of the Older Tertiaries of South Australia," "Additions to the Flora of South Australia." "The Lamellibranchs of the Older Tertiaries of South Australia."

BY-LAWS

RELATING TO SECTIONS IN CONNECTION WITH THE SOCIETY.

1. With the consent of the Council, Sections may be formed in connection with the Royal Society for the special study of particular branches of natural or applied science.

2. Such Sections shall consist of—

a. Members of the Royal Society who may desire to join the Section, and shall pay the annual subscription.

b. Other persons, not being members of the Royal Society, who shall have been regularly elected subscribers to the Section.

3. Members of the Royal Society who may join any of the Sections shall not be required to pay any entrance fee, and the annual subscription to be paid by them shall not exceed one-half of that to be paid by non-members of the Society.

4. The members of each Section shall elect their own Committee of Management.

5. The President and Vice-Presidents of the Royal Society for the time being shall be *ex-officio* members of the Committee of Management of all Sections that may be formed.

6. The rules and regulations for the management of all Sections shall be submitted to the Council of the Royal Society for their approval, and shall not have any effect until they have been formally approved by the Council.

7. Subscribers to the Sections shall have access to the library of the Royal Society, subject to such regulations as may be made by the Council.

8. The Committee of Management of each Section shall on or before 15th September of each year furnish to the Council of the Royal Society an annual report of the proceedings of the Section, with a balance-sheet, for publication (subject to the approval of the Council) in the Society's annual volume. A copy of such report shall be given to each member of the Section whose subscription for that year shall have been paid.

9. Sections shall be allowed the use of the Society's room at such times as may be approved by the Council.

10. All subscriptions received by any Section must be paid to the Hon. Secretary of the Royal Society, any funds required by such Section being supplied by the Parent Society. Sections should be as far as possible self-supporting, but grants of money may be made to any Section by the Council out of the general funds of the Society.

THE TREASURER IN ACCOUNT WITH THE ROYAL SOCIETY OF SOUTH AUSTRALIA.

Dr.	£	s.	d.	£	s.	d.
October 1st, 1884.						
To Balance brought forward				314	19	9
Subscriptions—Royal Society	98	8	6			
Field Naturalists' Sec.	18	5	0			
				116	13	6
Government Grant (first instalment)				99	0	10
Interest				12	10	0
Sale of Bookcase				25	0	0
				£568	4	1

Cr.	£	s.	d.	£	s.	d.
By Cost of Transactions—						
Printing and Binding	49	5	9			
Illustrating	36	1	0			
Publishing	4	5	11			
				89	12	8
Subscription to S.A. Institute (nine months)				9	0	0
Salaries, &c.—Assistant Secretary ..	21	0	0			
Attendant	1	7	0			
				22	7	0
Advertising				4	18	11
Printing, Postage, and Stationery ..				23	15	1
Field Naturalists' Section—Grants ..	55	0	0			
Stationery (Postal Microscopical Exchange)	3	14	0			
	58	14	0			
Less Repaid by Section	7	5	9			
				51	8	3
Balance—Bank of South Australia ..	139	16	3			
Savings Bank	250	0	0			
	389	16	3			
Less Outstanding Cheque ..	22	14	1			
				367	2	2
				£568	4	1

Audited and found correct,

LIONEL C. E. GEE, Auditor.

6th October, 1885.

WALTER RUTT, Treasurer.

DONATIONS TO THE LIBRARY

For the Year 1884-5.

I.—Transactions, Journals, and Reports.

Presented by the respective Societies, Editors, and Governments.

Ballarat School of Mines—Annual Report for 1884.

Baltimore—American Chemical Journal. By Ira Remson. Vol. VI., No. 4.

———— Johns Hopkins' University Circular. Vol. IV., No. 41.

———— Johns Hopkins' Third Series "Historical and Political Science;" VIII. "The Influence of the Proprietors in Founding the State of New Jersey."

Batavia—Catalogues des Bibliotheck van de Koninkligke-Natuurkundige Vereeniging in Nederlandsch-Indie.

Belfast—Report and Proceedings of the Belfast Natural History and Philosophical Society for 1883-84.

Berlin—Sitzungberichte der königlich-Preussischen Akademie der Wissenschaften zu Berlin; 1884. Nos. 18 to 39. XXX.-XXXI. and XXXIV.-XXXV.

Boston—Proceedings of the American Academy of Arts and Sciences. Vol. XI., parts 1 and 2.

Bruxelles—La Chronologie Geologique; Discours prononcé à la Séance Publique de la Classe des Sciences de l'Academie Royale de Belgique.

Buenos Aires—Boletin de la Academia Naçional Ciencias en Cordoba (Republica Argentina, Tomo 6, Entregas 2a y 3a.

Cambridge, U.S.A.—Annual Report of the Curator of the Museum of Comparative Zoology at Harvard College for 1883-84.

———————— Bulletin of the Museum of Comparative Zoology at Harvard College, vol. XII., No. 1.; vol. XI., No. 11.

———————— Studies from the Newport Marine Laboratory.

Cape Town—Transactions of the South African Philosophical Society, vol. iii., 1881-83.

Christiana—Den Norske Nordhavs Expedition 1876-78. XI. Zoologi-Asteroidæ. XII. Zoologi-Pennalulida. XIII. Zoologi-Spongiadæ. Geodätische Arbeiten, Heft IV. Vandstandsobservationer, Heft III. XIV. Zoologi, Crustaca, 1a and 1b.

Colorado—The Artesian Springs of Denver. Report by a Special Committee of the Colorado Scientific Society.

Dublin—The Scientific Transactions of the Royal Dublin Society, vol. 1, series 2, Nos. 20, 21 (two copies), 23, and 25. Vol. 3, series 2, Nos. 1, 2, 3.

——— Proceedings of the Royal Dublin Society, vol. 3, new series; parts 6, 7. Vol. 4, parts 1, 2, 3.

Edinburgh—Proceedings of the Royal Society of Edinburgh, Session 1881-82, 1882-83.

———— Proceedings of the Royal Physical Society, Session 1883-84; vol. VIII., part 1.

Göttingen—Nachrichter von der K. Gesellschaft der Wissenschaften und der Georg.-Augusts. Universität zu Gottingen, Aus dem Jahre, 1883; No. 1-13.

Halle, 1881-82-83—Leopoldina. Amptliches organ der Kaiserlichen - Leopoldino - Carolinischen-Deutschen Akademie der Naturforscher, 1881-82-83.

London—Proceedings of the Royal Colonial Institute; vol. XV.

——— Proceedings of the Royal Society; vol. XXXVII., Nos. 227 to 231.

——— Journal of the Royal Microscopical Society; Series II., vol. IV., Part 5, 6; vol. V., Part 1, 2, 3, 4.

——— Transactions of the Entomological Society of London for 1884.

——— Proceedings of Royal Colonial Institute, 1884-5.

Manchester, 1883—Memoirs of the Manchester Literary and Philosophical Society; vols. VII., IX., XX., and XXII.

Montreal—Geological and Natural History Survey and Museum of Canada. Report of Progress, 1882-83-84 (with forty maps in six sets), separate.

———— Do., do. Catalogue of Canadian Plants; Part 2, Gamopetalæ.

Munich—Sitzungberichte der mathematische-physicalischen Classe der Königlich-Bayerischen Akademie der Wissenschaften zu München. 1883-4.

——— Abhandlungen der mathematisch - physicalischen

Classe der Königlich-Bayerischen Akademie der Wissenschaften zu München. Denschriften 52, part 1.

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LIST OF FELLOWS, MEMBERS, &c.

November, 1885.

Those marked (F) were present at the first meeting when the Society was founded. Those marked (L) are Life Fellows. Those marked with an asterisk have contributed papers.

		Date of Election
HONORARY FELLOWS.		
Angas, Geo. French, F.L.S., C.M.Z.S.	London	1879
Barkley, Sir Henry, K.C.M.G., K.C.B.	.. .. ..	1857
Ellery, R. L. J., F.R.S.	Melbourne	1876
*Garran, A., LL.D.	Sydney	1853
*Hull, H. M.	Hobart	1855
Jervois, Sir W. F. D., K.C.M.G., C.B.	New Zealand	1878
Little, E.	.. .. ..	1855
Macleay, Hon. W., F.L.S., ..	Sydney	1878
*Mueller, Baron F. von, K.C.M.G., F.R.S.	Melbourne	1879
Russell, H. C., B.A., F.R.A.S., ..	Sydney	1876
Warburton, Col. P. E., C.M.G. ..	Beaumont	1858
*Woods, Rev. J. E. T., F.L.S., F.G.S.	Sydney	1877
CORRESPONDING MEMBERS.		
Bailey, F. M., F.L.S.	Brisbane	1881
Canham, J.	Stuart's Creek	1880
Chandler, T.	Peake	1881
*Cloud, T. C., F.C.S.	Wallaroo	1881
*East, J. J.	Mallala	1884
*Foelsche, Paul	Palmerston	1882
Goldstein, J. R. Y.	Melbourne	1880
*Hayter, H. H., M.A., C.M.G., F.S.S.	Melbourne	1878
Holtze, Maurice	Palmerston	1882
*Kempe, Rev. J.	Finke	1880
*Richards, Mrs. A.	Port Augusta	1880
*Scoular, Gavin	Smithfield	1878
*Stirling, James, F.L.S.	Omeo	1883
FELLOWS.		
*Adamson, D. B.	Adelaide	1867
Abbott, A. G.	Kingston	1884
Angas, J. H.	Angaston	1874
Beresford, D. J. D.	Adelaide	1884
Black, A. B.	Adelaide	1882
Boettger, Otto	Adelaide	1884
Brown, J. E., F.L.S.	Adelaide	1882
Brown, L. G.	Two Wells	1882
Browne, H. Y. L., F.G.S.	Adelaide	1883
Bruer, J.	Adelaide	1883
Brunskill, Geo.	Morgan	1878
Burchell, F. N.	Adelaide	1881
Bussell, J. W.	Adelaide	1884

*Campbell, Hon. Allan, M.L.C., L.R.C.P. Edin.	Adelaide	1882
Caterer, T. A., B.A.	Norwood	1882
*Chalwin, Thos., M.R.C.V.S. Eng.	Adelaide	1877
Chapple, F., B A., B.Sc.	Prince Alfred College	1876
*Cleland, W. L., M.B., Ch.M., F.R.M.S.	Parkside	1879
*(L) Cooke, E.	Adelaide	1876
*Cooke, W. Ernest, B.A.	Adelaide	1885
Cox, W. C.	Semaphore	1880
Cornish, W. H.	Adelaide	1883
*Crawford, F. S.	Adelaide	1865
*Davenport, Sir Samuel	Adelaide	1856
Davies, Edward	Adelaide	1882
Davis, F. W.	Adelaide	1882
Dobbie, A. W.	Adelaide	1876
Elder, Sir Thomas	Adelaide	1871
Evans, Thomas	Adelaide	1883
Farrar, G. E.	Adelaide	1882
*Fletcher, Rev. W. R., M.A.	Kent Town	1876
Foote, H.	Outalpa	1883
Fowler, W.	Kulpara	1882
Gall, David	North Adelaide	1865
Gardner, Wm., M.D., C.M.	Adelaide	1882
Gee, Lionel, C. E.	Adelaide	1882
Giles, G. F.	Adelaide	1883
Gill, George	Adelaide	1884
Gill, H. P.	Adelaide	1883
Gill, Thomas	Adelaide	1885
Gosse, John, M.R.C.S.	Wallaroo	1884
*Goyder, Geo., jun	Adelaide	1880
Grundy, E. B.	Adelaide	1882
*Haacke, Wm., Ph.D.	Adelaide	1882
*Harris, C. H.	Adelaide	1883
Harrold, A. L.	Adelaide	1876
*Haslam, John	Adelaide	1883
Hay, Hon. A., M.L.C.	Adelaide	1861
Henry, A., M.D.	Adelaide	1882
*Hill, W.	Mitcham	1884
Hopkins, Rev. W.	Adelaide	1880
*Howchin, W., F.G.S.	Goodwood East	1883
Hughes, H. W.	Booyoolie	1883
*Hullett, J. W. H.	Port Augusta	1876
Johnson, J. A.	Adelaide	1875
*Jones, W. E.	Parkside	1885
*(F) Kay, R.	Adelaide	1853
Kelly, Rev. Robert	Mount Barker	1884
Knevett, S.	Adelaide	1878
*Lamb, Prof., M.A., F.R.S.	England	1883
*Laughton, E.	Adelaide	1874
Lendon, A. A., M.D.	Adelaide	1884
*Lloyd, J. S.	Adelaide	1856
Magarey, A. T.	North Adelaide	1873
*Magarey, S. J., M.B.	Adelaide	1874
Mais, H. C., M.I.C.E.	Adelaide	1883
*Mayo, Geo., F.R.C.S.	Adelaide	1853
Mayo, G. G.	Adelaide	1874
Mestayer, R. L., F.R.M.S.	Adelaide	1883
*Meyrick, E., B.A.	Sydney	1881

Middleton, W. J. E.	Kangarilla		1882
Mohan, J. H.	Crafers		1883
Molineux, A.	Kent Town		1880
(L) Murray, Hon. David, M.L.C.	Adelaide		1859
Munton, H. S.	Adelaide		1884
Nesbitt, W. Peel, M.B.	England		1880
Neale, W. L.	Adelaide		1884
O'Leary, M. P., M.R.C.S.	Port Victor		1884
Parker, Thomas, C. E.	Port Adelaide		1883
Phillips, W. H.	Adelaide		1883
Pickels, W. E., F.R.M.S.	Adelaide		1883
Poulton, B., M.D.	Adelaide		1883
Rigaud, R. J.	Adelaide		1882
Robertson, R., F.F.P.S.	Adelaide		1882
*Rennie, Prof., D.Sc., F.C.S.	Adelaide		1885
Renner, F. E., M.D.	Carrieton		1885
Russell, William	Port Adelaide		1879
*Rutt, Walter, C.E.,	Adelaide		1866
Salom, Hon. M., M.L.C.	Adelaide		1866
*Schomburgk, R., Ph.D.	Adelaide		1865
*Smeaton, Stirling, B.A.	Adelaide		1882
*Smeaton, Thos. D.	Mount Barker		1857
Smith, E. Mitchell	Adelaide		1883
Smith, R. Barr	Adelaide		1871
Smyth, C. B.	Adelaide		1884
Smyth, J. Y., B.A., B.E.	Norwood		1882
Sparks, H. Y.	Glenelg		1878
Spiller, E.	Adelaide		1884
*Stirling, E. C., M.D., F.R.C.S., M.P.	Adelaide		1881
Stuckey, J. J., M.A.	Adelaide		1878
*Tate, Prof. R., F.G.S.	Adelaide		1876
*Thomas, J. D., M.D.	Adelaide		1877
Thow, William	Woodville		1878
*Tietkins, W. H.., F.R.G.S.	Millswood		1881
*Tepper, J. G. O., F.L.S.	Norwood		1878
*Todd, Charles, C.M.G., F.R.A.S.	Adelaide		1856
Tyas, J. W.	Adelaide		1882
Umbehaum, C.	Adelaide		1879
*Varley, A. K.	Mount Gambier		1883
*Verco, J. C., M.D.	Adelaide		1878
Vickery, G.	Meadows		1868
Ware, W. L.	Adelaide		1878
Wainwright, E. H., B.Sc.	St. Peter's College		1883
Watson, Rev. John	Parkside		1884
Way, E. W., M.B.	Adelaide		1879
Way, S. J., Chief Justice	Adelaide		1859
Wheeler, F.	Adelaide		1884
White, R. A.	Adelaide		1882
Whiting, J. B.	Adelaide		1882
*Whittell, H., M.D., F.R.M.S.	Adelaide		1882
Woodward, H. P., F.G.S.	Adelaide		1883
*Wragge, C. L., F.R.G.S.	Adelaide		1877
Wyatt, Wm., M.R.C.S.	Burnside		1859
Young, Wm., M.A.	Hindmarsh		1880

ASSOCIATES.

Burchell, D.	Adelaide		1883
Hodgson, Mrs.	Port Victor		1884

APPENDIX.

PROCEEDINGS

OF THE

Field Naturalists' Section of the Royal Society

1884-85.

RULES OF THE FIELD NATURALISTS' SECTION.

1. The general management of this Section shall be controlled by a Chairman, two Vice-Chairmen, a Secretary, and a Committee of eight, five to form a quorum.

2. The Chairman, Vice-Chairmen, and Committee shall be elected at the annual meeting in October.

3. The Chairman shall not be eligible for office for more than two consecutive years, and one of the Vice-Chairmen shall retire each year.

4. Candidates for admission, not being members of the Royal Society, must be proposed and seconded by two members of the Section at one meeting, and be balloted for at the next ensuing meeting; one black ball in five to exclude.

5. Evening meetings shall be held on Tuesdays, at the discretion of the Committee of Management, for the purpose of reading papers, dealing with the natural history of Australia (more particularly of the neighbourhood of Adelaide), or for the purpose of mutual instruction.

6. There shall be at least eight Field Meetings during the year; the time and place to be arranged by the Committee.

7. At the annual general meeting a statement of accounts shall be submitted by the Secretary and duly certified by two auditors appointed at the previous ordinary meeting, preparatory to being handed to the Treasurer of the Royal Society.

8. The Section may from time to time elect as honorary members those who have been proposed and seconded in the usual way, and have been unanimously elected by ballot. This shall also apply to corresponding members.

9. Any member owing the subscription to the Section and neglecting to pay the same on or before the first day of January, shall be liable to have his name removed from the list of members of the Section; provided always that written application for the same shall first have been made by or on behalf of the Treasurer of the Royal Society; and, provided also, that the Committee shall have power to restore the defaulter's name at his request, after payment of arrears.

10. The rules and regulations of the Section shall not be altered unless a

written notice of motion, signed by not less than five members, be given at a meeting of the Section; and thereupon such motion may be brought forward at the next meeting.

11. Any resolution passed under rule 10, altering or repealing the rules of the Section, shall be in force until the meeting held in the month of October following; and if not then confirmed, shall thereafter be held void and of no effect.

12. On the written requisition of twenty members, delivered to the Secretary, an extraordinary general meeting may be called to consider and decide upon the subject mentioned in the requisition.

13. The Committee shall be empowered to frame rules for the conduct of excursions arranged for by them.

14. Fellows of the Royal Society who are members of the Field Naturalists' Section shall pay to this Section an annual registration fee of one shilling each.

REGULATIONS OF THE ROYAL SOCIETY FOR THE FIELD NATURALISTS' SECTION.

1. This Section is established to promote the practical study of Natural History by affording fuller opportunities and facilities for meeting and working together.

2. The Section shall consist of—

(*a*) Fellows and Associates of the Royal Society who shall have signed the rules of the Section.

(*b*) Ladies and gentlemen, not members of the Royal Society, who shall become subscribers to the Section.

3. The members of the Section shall elect their own Committee of Management.

4. Subscribers to the Section shall pay annually, in advance, five shillings; the year to terminate on the 31st day of October.

5. Subscribers to the Section shall have access to the Library of the Society, and shall be entitled to a copy of the "Miscellaneous Contributions to Natural History" and the "Annual Reports" published by the Society for the current year.

6. The Committee of Management shall furnish to the Honorary Secretary of the Royal Society an annual report of the proceedings of the Section in time for publication in the Royal Society's annual volume.

7. By application to the Council of the Royal Society grants of money may be made to the Section out of the general funds of the Society.

RULES FOR THE CONDUCT OF FIELD EXCURSIONS.

1. Each member shall have the privilege of introducing two friends, such privilege not to extend to any person who shall have been a visitor at two successive meetings.

2. A Chairman to be elected as at ordinary meetings.

3. The Secretary to act as conductor, or in his absence, some member of the Committee nominated by him.

4. No change to be made in the programme, or extra expense incurred, except by the consent of two-thirds of the members present.

5. No fees, gratuities, or other expense to be paid except through the conductor.

6. Every member or visitor to have the accommodation assigned by the

conductor. Where accommodation is limited, consideration will be given to priority of application.

7. Accommodation cannot be supplied unless tickets are obtained before the time mentioned in the special circular.

8. Those who attend an excursion without previous notice will be liable to extra charge, if extra cost be thereby incurred.

9. No intoxicating liquors shall be provided at the expense of the Section.

———o———

EXCURSIONS.

First Excursion—Monday, November 10, 1884.—Golden Grove, &c.

About fifty ladies and gentlemen proceeded on this date by coach to Golden Grove, Bishop's Springs, and the gorge of the Little Para River. On arrival at Bishop's Springs a meeting was held, at which five new members were elected, and votes of thanks passed to the Right Rev. C. A. Reynolds and Mr. John Robertson, J.P., for their courtesy in permitting members of the Section to make use of their grounds. Prof. Tate then addressed the party, and said he was glad to avail himself of the opportunity of explaining to the members a few of the salient rock features of the locality. They consisted of thickly-bedded sandstones and grits forty to sixty feet thick, and intercalated among clay slates. There were four of these bands, and where they were intersected by the stream-courses they formed waterfalls. They were traceable on the surface as colossal walls, and on the elevated grounds appeared at a distance like Cyclopean ruins. From their moderate dip and the varying slopes of the ground, and the presence of two deep waterways, the outline on the surface of the grit bands somewhat resembled a collection of the letters V and W, all inverted, and altogether afforded very interesting examples of the chief phenomena of stratification. These bands, which had previously been supposed to be of igneous origin, had been proved by Mr. Scoular, who had studied them at this and neighbouring places, to be of sedimentary origin, some evidences of which (such as the lamination of the lower part of the grits) were observable in the sections examined by the party. The position of these bands, in addition to forming a waterfall, had caused a deflection of the stream which flowed along the base for several hundred yards, by which a long mural line of cliff is maintained. This was the habitat of a rare plant in the southern portions of the colony, the *Scleranthus pungens*. The Professor indicated that a botanical feature was noticeable in connection with the grits, viz., the prevalence of the sheaoak (*Casuarina quadrivalvis*), and explained that even where the grits did not form any marked outcrop, their presence was in-

variably determined by the existence of this forest tree, especially in the broad belt of timber that crowned the main road approaching Golden Grove. The graceful poison-berry tree, *Pittosporum phillryæoides*, is here exclusively confined to the same habitat in this locality. *Bulinus texturatus* was collected in the river. The habitat of the *Quinetia Urvillei*, a very rare annual of West Australian origin, discovered here some years ago by Professor Tate, was visited. Here *Ptilotus erubescens* was found; and then the scrub at Golden Grove was explored, but the many floral productions for which it is famous had now almost passed away. A few, however, remained, among which were *Daviesia ulicina*, var. *ruscifolia*, and the grass *Amphipogon strictus*. The Professor explained that the surface drainage from the scrub had in the course of a few years cut for itself a channel some yards in width, and of a depth of twenty feet in the sands and clays which overlie the sandstones and stiff argillaceous beds of the "Upland Miocene." The same beds were also visible in the roadside cuttings, where the horizontal arrangement of these sandstones are unconformable to the grits of the old rocks. The peculiar vegetation of these scrublands was at this place clearly seen to be referable to this geological phenomenon.

Second Excursion—Thursday, January 1, 1885.—Uraidla.

About thirty members and friends of the Section proceeded to Uraidla via Norton's Summit. On arrival at Uraidla the party were met by Mr. Grasby, of Oakbank, and Mr. Wilson, of Uraidla, who courteously volunteered their services as guides.

After walking for about a mile a meeting was held—Mr. W. H. Selway, jun., presiding—and two new members elected, and a hearty vote of thanks passed to Mr. Wilson. The party then descended to the foot of a waterfall at the head of a beautiful glen.

After lunch the walk was commenced, and on the way attention was directed to the undulated foliation of the slates and quartzitic grits wherever exposed in the rocky walls bordering the deep gullies along which the road lay, and which was produced by lateral pressure. The talcose slates generally occupy the lower portions of the hillsides, while the quartzites dominate the ridges, which are usually occupied by the stringybark forests. It was pointed out that the configuration of the country, inclusive of almost equi-distant secondary lateral gullies, was due to erosion by the agency of rain upon strata of different densities. The formation was the same as that formerly observed at Crafers and the neighbourhood of

Mount Lofty, which was composed of rocks of pre-Silurian age, concealed mostly by soil formed by their disintegration, and, so far as known, devoid of fossils. There was much that was interesting in the botanical features of the trip, and Mr. Tepper indicated that as the elevation above the level of the plain increased the vegetation changed considerably in character. Near the foot of the rise the peppermint gum, *Eucalyptus odoratus*, was met with, reaching to a height of more than 1,000 feet above sea level, where *E. leucoxylon* (blue gum) took its place; this at a height of 1,300 or 1,400 feet being succeeded by the two stringybarks *E. obliqua* and *E. capitellata*. In the stringybark level were found in flower *Leptospermum myrsinoides* and *Gompholobium minus*. The latter is generally yellow, but a brilliant red specimen was also found. *Candollea graminifolia*, with its sensitive style, the climber *Marianthus bignoniaceus*, *Aster Sonderi* (flowers pure white, and about two inches across), *A. Huegelli* (both purple and white), *Comesperma calymega*, were also gathered. In the highest elevations were *Brunonia australis*, *Pultenea villifera*, and a few late specimens of the orchid *Dipodium punctatum*. The two sedges *Lepidospermum carphoides* and *L. filiforme* were found on the road leading to Norton's Summit. *Eryngium rostratum*, with blue flowers almost hidden in a curious spray-head of foliage, the large white flowers of *Pimelea octophylla* and *P. glauca*, were also found. At the foot of the waterfall were fine specimens of *Veronica Derwentia*, about six feet high, with conical spikes of white flowers, and *Epilobium tetragonum*, var. *pallidum*, with long pale pink flowers. The ferns *Lomaria discolor*, *L. capensis*, *Adiantum æthiopicum*, and *Osmunda* (*Todea*) *barbara* were setting their spores. Amongst a large number of plants in fruit were *Daviesia corymbosa*, *D. ulicina*, and *D. brevifolia*; *Stackhousia* sp., *Dillwynia hispida*, *Xerotes sororia*, and two other species.

Third Excursion—Saturday, Jan. 24, 1885.—Ambleside.

About forty ladies and gentlemen left by the 1.10 train for Ambleside, and on arrival there a start was made for the banks of the River Onkaparinga. After a meeting, under the presidency of Professor Tate, at which four new members were elected, Mr. E. Guest led the way northwards. In spite of the lateness of the season, the district was rich in botanical specimens.

Among the plants found were *Opercularia ovata*, *Mentha gracilis* and *M. australis*, *Hypericum japonicum*, *Alternanthera triandra*, *Brachycome graminea*, *Epilobium tetragonum*, *Polygonum minus*, *Myriophyllum variifolium* and *M. elatinoides*,

Potamogeton obtusifolius, *Helichrysum rutidolepis*, and *Potentilla anserina*. This last is said to be found only in this immediate locality. Mr. Tepper was fortunate to discover *Haloragis heterophylla*, distinguished by its digitate leaves. The tall shrubs by the riverside — *Bursaria spinosa*, *Leptospermum lanigerum*, and *Acacia retinodes*—were in full flower. *Lythrum salicaria*, with its purple flowers, was also gathered.

Of the sedges collected, the most noteworthy were *Cyperus lucidus*, *C. textilis*, *Juncus planifolius*, *J. prismatocarpus*, *J. cæspititius*, and *Scirpus inundatus*. Of grasses, the tall *Poa caespitosa* was found in fruit, together with *Echinopogon ovatus* and *Eragrostis Brownii*, and *Ehrharta stipoides*. On the railway line *Hæmarthria compressa* was seen in flower, and varieties of the aquatic plant, *Triglochin procera*, were in full fruit.

The party followed the Onkaparinga as far as the railway bridge, and then returned to the station, which was left at 4.45, the city being reached shortly after 6 o'clock.

Fourth Excursion—Saturday, Feb. 14, 1885.—Largs Bay.

The members assembled at the North-terrace Railway Station at a later hour than usual, and proceeded to Largs Bay. On arrival there Mr. J. G. O. Tepper presided over a business meeting, at which two new members were elected. He then introduced Mr. W. T. Bednall, who had consented to act as leader.

Mr. Bednall explained that the weather had scarcely been conducive to the chance of finding many good marine specimens, but by careful search the members might add something valuable to their collections. He pointed out that the *Venus scalarina* (the common cockle) was the predominant shell in this locality, its distribution being very local and confined from Largs Bay to about a mile south of the Semaphore. From there southwards this shell was replaced by another sand-living bivalve, the *Mactra polita*, only a very few specimens of which were taken. Mr. Bednall then suggested a number of other species of shells that might be found; but, as he intimated at first, the result of the searching was not particularly interesting.

After being advised to collect the sand and small shells which would be found in little heaps, and to dry it for examination under the microscope, when there would probably be discovered beautiful specimens of small shells, diatoms, foraminifera, and corallines, the party took a northerly direction along the beach.

During the journey Mr. Tepper explained that there was a distinction between the submarine flowering plants and seaweed. The plants *Cymodocea antarctica* and *Posidonia australis*, found in such large quantities on the beach, were commonly mistaken for algæ (seaweed). The difference shown in the appearance of the seaweed and the seaplant was very marked; but the distinction in classification seemed to be rather finely drawn. A good specimen of *Halophila ovalis* (marine plant) and some others were shown, but nothing worth mentioning was found in algæ, probably because the attention of the members seemed to be confined to the shells. Very few specimens were taken alive, but a fairly good collection was made of *Triton Quoyi*, *Nassa fasciata*, *Columbella Lincolnensis*, *Natica conica*, *Sigaretus zonalis*, *Conus rutilus*, *Bittium turritella*, *Mactra pura*, *Hiatula biradiata*, *Arca lima*. Only broken specimens of *Pecten australis*, *P. bifrons*, and *P. laticostatus* could be obtained by such a casual examination. *Solemya australis* was uncommonly abundant, but small and in parts only. *Phasianella bulimoides* (pheasant shell) was rather scarce. Mr. Molineux obtained one of the latter alive, which he explained had, by the appearance of the shell, evidently at some time been attacked by a stingray, but eluded the enemy. The shell had been broken, and had grown again with an additional patch on the outside, which was not an infrequent occurrence. Much interest was imparted to the excursion by little dissertations upon the habits of land and marine life, in many cases a very complete comparison being made.

Fifth Excursion—Saturday, March 7, 1885.—Bridgewater.

The party arrived at Bridgewater about 2.30, where they were met by Professor Tate, and started to walk down Cox's Creek, along which they proceeded for about a mile. On the way were seen the creeper *Marianthus bignoniaceus*, and the native fuchsia, *Correa decumbens*, with yellow as well as red flowers. Along the banks of the creek was discovered the handsome sedge, *Cladium Mariscus*. The blue-bell, *Wahlenbergia gracilis*, was found in abundance, and it was stated that this plant had been exhibited at the Royal Agricultural Show as a fodder-plant, whereas if not poisonous it was at least very unwholesome. *Lobelia microsperma*, which plant is stated to have caused the death of much valuable stock, was noticed, as was also the white everlasting, *Ixodia achilleoides*, a flower peculiar to the Mount Lofty Ranges and the South-east Desert. The bright *Goodenia ovata* was very plentiful.

The party eventually arrived at a waterfall, the basin of which is enclosed on three sides with high rocks. Professor

Tate explained that the higher ground here was composed of grits and friable sandstones, while the hard grits made up the valley bottoms. The "potholes" on the face of the rocky bed forming the rapids were stated to have been caused by stones being caught and retained by the eddying current until holes were worn into the rock.

On the return from the waterfall Professor Tate pointed out the curious parasite, *Cassytha pubescens*, festooning *Acacia retinodes*, and drew attention to the sedge *Cladium psittacorum*, the tallest of its kind in Australia. At five o'clock the Section left Bridgewater, and reached the city shortly after six.

Sixth Excursion—April 6, 1885 (Easter Monday).—Highercombe.

About thirty-five members and friends proceeded to Highercombe, the party being led by the Rev. J. McEwin. On approaching the hills the different character of their vegetation, some giving light and others a dark tinge, was pointed out. This was explained to be due to the habitat, chiefly determined by the soil and underlying rocks; the dark hills (on which grew shrubs and sedges) being formed of sandstones and other silicious rocks, while the light-tinted hills, which were mostly covered with grass, were composed of shales and slates. The superposition of the Tertiary clays and gravels upon the older rocks at the foot of the hills was also pointed out. The Eucalypti were also noticed to differ from those further south.

On arriving at Highercombe the party visited the beautiful gardens and grounds of the Hon. R. D. Ross, who very kindly granted permission to inspect his property, the chief feature of which was the number of English forest trees. After luncheon the Hon. R. D. Ross led the party to a picturesque gorge, which was about fifteen feet wide, its perpendicular rocks rising some 200 feet above the river. After leaving the gorge and following up the creek back to the gardens, there were found *Callistemon saligna*, *Leptospermum lanigerum*, forming dense thickets, among which were found *Correa decumbens*. A tuft of *Andropogon lanigerum* was also found, and some rare mosses and lichens on the rocks; the latter consisted of quartzose and talcose schists and shales, inclined at rather high angles.

The season being so far advanced, very few flowers were observed. On the way back from the gorge the party visited the "Echo," a face of rock rising some 300 feet above the river.

The coach was reached about five, and the party, after par-

taking of Mr. Ross's hospitality, left at 5.30, the homeward route being *viâ* Anstey's Hill and through Paradise.

Seventh Excursion—April 18, 1885.—Second Gully.

About twenty members and friends proceeded to Burnside, Mr. G. Collis, Jun., acting as Secretary, and Mr. J. G. O. Tepper, F.L.S, and Mr. W. Howchin, F.G.S., being the scientific instructors. Shortly after leaving the tram attention was called to a peculiar hard and coarse conglomerate exposed on the bank of the creek. Mr. Howchin expressed the opinion that it was an ancient remnant of the gravel of the local watercourse, when the stream flowed at a considerably higher level. The party then ascended the Greenhill, where two very distinct varieties of *Vittadinia australis* were pointed out. Mr. Tepper directed the attention of the members to the distinct zones of Eucalypts. The relation of the vegetation of the hills to the rocks of which they were composed was referred to in order to show that from the aspect of vegetation conclusions as to the prevailing but hidden rocks could be drawn, just as from the known existence of certain rocks the character of the plants could be inferred.

The view from the top of the hill having been admired, the gully below them, with its steep scrubby declivities and perpendicular weathered cliffs was the object of attraction. On the steep side of the Greenhill some bushes of the South African *Gomphocarpus fruticosus* were found perfectly naturalised. The dicœcious character of the sheaoak (*Casuarina quadrivalvis*) was pointed out, and the junction of the two species of grasstrees (*Xanthorrhœa semiplana* and *X. quadrangulata*) was well shown at one place, the former extending from the spot downwards and the latter upwards. In the bed of Slape's Gully Mr. Tepper pointed out a native grass (*Ehrharta stipoides*) as being eminently suitable for lawns. The *Epacris impressa* was found to be just in bloom, other plants in flower being *Wahlenbergia gracilis* (bluebell), *Oxalis corniculata* (yellow), *Styphelia Sonderi* and *S. humifusa*, *Scævola microcarpa*. *Bursaria spinosa* had but few flowers, but more fruit. The following ferns were noticed:—*Cheilanthes tenuifolia*, *Grammitis rutæfolia*, *Lomaria capensis*, *Asplenium flabellifolium*, and a few early specimens of Maidenhair (*Adiantum æthiopicum*).

Eighth Excursion—Saturday, May 16, 1885.—Port Creek.

Owing to the threatening weather only a few members attended this excursion. On arrival at Alberton the party

proceeded under the guidance of Professor Tate in a southerly direction, and shortly after crossing the Port-road struck a course for the Port Creek. A short business meeting was held *en route*, and a new member elected. On nearing the creek attention was called to the *Scirpus nodosus*—a rush-like sedge, the roots of which bind the drifting sand. On reaching the mud-flats, the tide being low, a good opportunity was afforded in searching for molluscs under the salsolaceous bushes. Here were found *Ampullarina Quoyana*, *A. fragilis*, and *Pomatiopsis striatulus*, and the following plants in flower:—*Atriplex semibaccata*, *A. paladosa*, *Kochia brevifolia*, *Frankenia lævis*. Further inland a permanent pool of water was visited, and proved to be exceedingly rich in molluscan life, amongst which were species of *Bittium*, *Tatea*, *Bythinella*, *Trochocholea*, &c., these being entangled in tow-like confervæ. Several *Isopods* and other crustaceans were also found. In the same water were seen several sea anemones of a brown colour, with dark bands across the tentacles, their existence in this locality causing considerable astonishment. The following plants were met with on the sandhills:—*Wahlenbergia gracilis*, *Erechtites quadridenta*, *Salsola kali*, and *Xerotes effusa*. The mangrove (*Avicennia officinalis*) was observed to be in flower.

Ninth Excursion—Monday, May 25, 1885.—Marino.

Some fifty members and friends started by the 9.5 a.m. Glenelg train in reserved carriages. Alighting at Miller's Corner, the party found a special tramcar waiting to take them to Brighton. On the road leading to the beach, and at the edge of the sand-dunes, attention was called to a thick growth of the Sarsaparilla (*Muehlenbeckia adpressa*). Just opposite to this a halt was called, when Professor Tate stated that they were evidently on the edge of a low escarpment consisting of red loam, in which were to be found pebbles and marine shells, such as whelks and the valves of the mactra, these being thrown up by the action of the waves. At no distant period the land had increased owing to the piling action going on in the formation of the sand-dunes. The red loam referred to projects out to the sea, and explains the existence of fresh-water springs, these being the drainage from the sand-hills kept in its place by the clayey soil. Mr. Luxmoore, whose residence adjoins the road on which the party were gathered, invited them to go on to his property, where could be seen a large number of the pebbles previously referred to, their presence having caused some perplexity to the owner, who thought they might have been placed there by human agency. The

locality did not possess the constituents of a raised beach, and the only feasible explanation of these pebbles getting into their present position was to be found in the force of the breakers carrying them there. It was remarked in this connection that the land hereabouts was gradually encroaching on the sea, and the "gathering" action could be plainly noticed. Arriving on the beach the potash-plant (*Salsola kali*) was noticed, from which the potash of commerce was formerly obtained. This plant is generally found inland in dry saline country, and is not often seen on the seabeach. Leaving the beach for a moment, the party were taken to the foot of the sandhills to inspect a pool of fresh water. Returning to the beach the party resumed the walk. A portion of the beach was soon reached, which was stated to be a good collecting ground (after rough weather) for the conchologist, and a little further on a few scattered stones of an angular shape were noticed, the reason for their not being smooth was that they were not sufficiently numerous to rub against each other. Soon the shingle beach was arrived at, and beyond this the rocks. Having traversed this uncomfortable locality (so far as walking is concerned) for a short distance, the party halted, and the Professor directed attention to what was evidently an anticlinal axis, the strata at this part dipping in opposite directions, that to the south-east being the most plainly marked. The rocks found here, he stated, were amongst the oldest in Australia. An *al fresco* luncheon was then partaken of, after which the party walked up one of the ravines so numerous in this locality, and were afforded an opportunity of inspecting *in situ* the crystalline limestone, from which material it had been attempted to make Portland cement, but on account of its silicious nature it was unsuitable for the purpose. On the sides of this gully several interesting botanical specimens were met with, amongst which may be mentioned the grass *Pappophorum commune*, which is not often found in these parts, its favourite haunts being in the North; *Boerhaavia diffusa*, *Sida corrugata* (a desert species). Emerging from the ravine, a course was shaped in a westerly direction, and the hills forming the terminus of the foothills, Mount Lofty Range, which here trend towards the coast, were next explored. In these parts the sweet-smelling *Xerotes effusa*, the ubiquitous *Wahlenbergia gracilis*, and *Styphelia patula* were found. The carnivorous plant (*Drosera Whittakeri*) excited much attention, and a leafless shrub took some time to identify, the *savans* of the party holding different opinions on the subject. It was eventually pronounced to be *Exocarpus aphylla*, but its close resemblance to *Leptomeria* rendered identification difficult in its present state. Amongst other plants which may be recorded as found here may be mentioned *Grevillea lavan-*

dulacea, *Scleranthus pungens*, *Senecio odorata*, *Calocephalus Brownii*, *Rhagodia Billardieri*, *Alyxia buxifolia*, and the poisonous *Euphorbia Drummondi*. A few flowers of the beautiful *Hakea rugosa* were gathered. One, and one only, of the orchids was noticed, this distinction falling to *Pterostylis mutica*, and this was not in flower. Having thus enriched their botanical collections, the party returned to the rocks near which they had taken their luncheon in the morning, and shortly after 2 o'clock started on the homeward journey. They had not proceeded far when attention was called to what seemed the remains of an old beach near the top of the cliff. Prof. Tate explained that it belonged to the Older Tertiary period, and that similar beds had been seen in greater force at Hallett's Cove (three or four miles further down the coast), when the Section had paid that place a visit some time ago.

Leaving this interesting section, search was made for a well which was said to be in the vicinity. Ere long a spring was noticed, but its water was too brackish to be palatable. Next came what was perhaps the hardest piece of climbing done during the day, viz., the ascent of the high hill in front of the house formerly occupied by the late Sir George Kingston. From the summit a magnificent view was obtained.

The party, after a short rest, resumed their walk in a direct line for the tram stables, and on arrival there found a tramcar waiting, which started in time to meet the 5 o'clock train from Glenelg, the city being reached at 5.30.

Tenth Excursion—Saturday, June 13, 1885.—Botanical Gardens.

It was arranged that the Section should pay a visit to the Gardens on this date, but owing to the almost incessant downpour of rain only about half a dozen members put in an appearance. These spent the afternoon in the "Museum of Economic Botany," and were much pleased and interested with the admirable collection of botanical products which Dr. Schomburgk has arranged in this building.

Eleventh Excursion—Saturday, July 11, 1885.

This date was fixed for a visit to the Zoological Gardens, but the afternoon proved exceedingly wet; and as only a few members attended, no meeting was held.

Twelfth Excursion—Saturday, August 15, 1886.

It was intended to make an excursion to the Grange on this date, but, as in the case of the two previous meetings, the inclement weather frustrated the plans of the Section. A few members carried out the programme, and collected on the beach a large variety of algæ, shells, sponges, sea-eggs, &c., which had been washed up by the recent rough weather.

Thirteenth Excursion—Tuesday, September 1, 1885.—Hallett's Cove.

Between forty and fifty members and friends proceeded to Hallett's Cove. Shortly after nine o'clock a start was made from the Town Hall, the route lying through Edwardstown and the Sturt, where a short stop was made prior to ascending Tapley's Hill. The gentlemen dismounted from the vehicles and walked up the steepest part of this gradient, noting as they went the slaty rocks and quartzites of which this hill is mainly composed. Arriving at the summit, and just after passing the ten-mile post, the road to the right was taken, which leads to O'Halloran Hill. Another turn—this time to the left—and then an almost direct course to Hallett's Cove was shaped, the destination being reached at about half-past eleven. Dismounting, the party made for Field's River, on the banks of which luncheon was partaken of. This part of the day's proceedings over, the Honorary Secretary (Mr. W. H. Selway, jun.) assembled the party, and explained the programme of the day's operation. Under the guidance of Mr. J. G. O. Tepper, F.L.S., a southerly direction was first taken, and the coast cliffs explored for flowers, which were seen in great profusion. The peculiar flora of this locality very closely resembles that of the opposite coast of Yorke's Peninsula. Approaching still nearer the coast, the members hoped to find some rocks giving evidence of glacial action, but, as these were further off than was thought, it was resolved to strike a direct course for a point some distance up Field's River, passing over a good deal of rough country on the way thither. The river was ascended for a short distance, and the stratigraphical formation of its picturesque cliffs was viewed with much interest. These were noticed to consist chiefly of masses of limestone, shales, and sandstones, very curiously crumpled, and with slaty bands occasionally interstratified. The watercourse was found to be almost covered with a species of *chara*, and among the reeds and rushes were noticed an unusually large form of *Apium prostratum* and the tall *Triglochin procera*, both in flower. One or two gentlemen who had gone to the beach returned with some very fine specimens of starfish, one especially being

of immense size and very beautifully marked. In two or three places the party found some very large boulders of granite, for the presence of which amongst the general geological features of the locality they were unable to account, except upon the hypothesis that they were glacial erratics.

After a short rest a start was made for the north side of the Cove to inspect the rocks about half a mile distant which created such interest on the previous excursion, viz., those on which the signs of ice action are to be found. The polished and striated face of the rock was shown, and those geologists of the party who had seen similar and undoubted marks of ice action in England agreed that Professor Tate, who discovered this rock, was quite justified in assigning them to the agency indicated. It was intended to search for fossils in the Tertiary beds on the way back to the coaches, but there was not sufficient time for this.

During the day the following plants (generally found only in mallee country) were collected in flower, viz.:—*Erysimum brevipes*, *Pittosporum phillyriæoides*, *Claytonia calyptrata*, *Mesembrianthemum æquilaterale*, *Enchylæna tomentosa*, *Ptilotus spathulata*, *Muehlenbeckia adpressa* (Native Sarsaparilla), *Zygophyllum fruticulosum*, var. *angustilobium*, *Stackhousia linarifolium*, *Pultenæa tenuifolia*, *Swainsonia phacoides*, *Glycine clandestina*, *Kennedya prostrata*, *Acacia spinescens*, *Tillæa macrantha* and *T. purpurescens*, *Hydrocotyle callicarpa*, *Pimelea curviflora* and *P. glauca*, *Grevillea lavandulacea*, *Hakea rugosa*, *Minuria leptophylla*, *Brachycome pachyptera* (both very pretty white starlike flowers), *B. tenella*, *Craspedia Richea* (the "Billy Button"), *Podolepis acuminata* (one of our largest-flowered composites), *Microseris Forsteri* (native yam), *Leeuenhoekia dubia*, *Velleia paradoxa*, *Bulbine bulbosa*, *Xerotes glauca*, *X. nana*, *Schœnus Brownii*, *Dampiera rosmarinifolia*, *Logania linifolia*, *Nicotiana suaveolens* (native tobacco), *Euphrasia Brownii*, and *Westringia rigida*. Of Orchids the following were gathered:—*Diuris palustris*, *D. pedunculata*, *Caladenia Patersoni*, *C. latifolia*; and three varieties of ferns, viz., *Ophioglossum vulgatum*, *Cheilanthes tenuifolia*, and *Grammitis rutæfolia*.

The party assembled at the coaches shortly before five o'clock. and after an enjoyable drive reached the city at 6.45.

Fourteenth Excursion—Saturday, September 12, 1885.—Magill and Horsnell's Gully.

On Saturday, September 12, an excursion to Magill and Horsnell's Gully was made by about 20 members and friends, this being the first visit by the Section to that part of the

hills. The party left the city at 1.10 p.m. in a special tramcar, and, on arriving at Magill, started to walk up the Norton's Summit road, under the guidance of Professor Tate, F.G.S., F.L.S. They had not gone far when attention was called to a bed of conglomerates on the right-hand side of the cutting. These were resting on the upturned edges of slates, and probably indicated the recession of a former watercourse, the present channel not being far away, but at a considerably lower level. Resuming the walk the first flower gathered was soon afterwards found, viz., *Scævola microcarpa*, one specimen of which possessed additional interest on account of having a gall attached to its stem—a phenomenon somewhat rare on this plant. Attention was next called to the silver wattle (*Acacia retinodes*), which was in fruit, and on the leaves of which tree numerous galls were also seen. After walking a little farther, the road branching off to the right and leading to Horsnell's Gully was taken. Flowers here were very numerous, one of the first to attract notice being the pretty white *Logania longifolia*, while the beautiful light-yellow clusters of *Clematis microphylla* divided the honours with the first-named. *Glycine clandestina* and *Sherardia arvensis* were also collected here, and one or two flowers were already noticeable on the *Banksia marginata*. Attention was called to the poisonous *Swainsonia lessertiifolia*, which has acquired some notoriety on account of having caused the death of sheep in the South-East. The delicate white and spotted flowers of *Myoporum viscosum*, with its rich dark-green foliage, had a great many admirers. After considerable search a few specimens of *Corysanthes pruinosa* were discovered, but none in flower. Attracting notice from its brilliant yellow flowers, *Pultenæa daphnoides* was soon added to the collection. After passing a bank thickly covered with Cape Broom in bloom (*Genista canariensis*) the party arrived opposite a very fine and somewhat pyramidal-shaped bluff of rock composed of sandstones and grits, and near here in a pleasant shady spot a short rest was indulged in. A few of the party scaled the hillsides, and found three kinds of orchids, namely—*Pterostylis nana*, *Diuris maculata*, and *D. pedunculata*, there being a little doubt, however, as to whether the last of these was correctly named or not. Two other orchids gathered during the afternoon were *Pterostylis curta*, with its curious hooded appearance and green flower, and *Caladenia Patersoni*. Near the resting place was observed *Kennedya prostrata*. *Kennedya monophylla* (native lilac) was also abundant. Their energies sufficiently recruited, the party continued the walk in the same direction, amidst picturesque scenery. Soon were observed the myrtle-leaved wattle (*Acacia myrtifolia*) in bloom, and the sweet-

scented mauve-coloured flowers of *Tetratheca ericifolia*. Mr. J. G. O. Tepper, F.L.S., here directed the attention of members to a curious tuft-like proliferation found growing on a eucalypt, and said that the part of the tree above this growth subsequently dies. He stated that the cause of it was at present unknown, but that it was well worthy of investigation by scientists, pointing out that to the successful discoverer distinction was almost certain. The carnivorous sundew *(Drosera Whittakeri)* was rather plentiful. The following ferns were gathered, viz.:—*Adiantum æthiopicum* (maiden hair), *Cheilanthes tenuifolia* (the common rock fern), *Lomaria discolor*, and *L. lanceolata*, *Grammitis rutæfolia*, and *G. leptophylla*. It was now considered time to turn back, and not wishing to scale the precipitous hills by which they were surrounded, the party determined to return by the way they had come, a few members examining the creek *en route* in search of mosses, &c. Amongst other flowers, not previously mentioned, which were collected were *Cæsia vittata*, *Goodenia geniculata*, and *Stackhousia linarifolia*. The excursionists, each laden with floral treasures, returned from Magill by the 5.15 tram.

Fifteenth Excursion—Saturday, October 10, 1885.—Highbury.

On Saturday, October 10, about thirty ladies and gentlemen proceeded to Highbury, starting from town at 1.40 p.m., in one of Hill & Co.'s coaches. On arrival at Highbury a start was at once made under the guidance of Prof. Tate, F.G.S., F.L.S. into the scrub to the south of the road. After walking about 100 yards an excavation was reached, and this being a convenient place to point out the geological features of the locality a short stoppage was made. Having disposed of some formal business, Professor Tate addressed the members, and stated that they were on a little patch of scrub which had lost some of its characteristics by over-cropping. This scrub land was very limited in its extent, and was a remnant of a considerable sheet that extended all along the foot-hills of the main range, and was seen in stronger force at Golden Grove, to the north of which still larger patches were met with. These patches were generally recognised externally by the sanddrift that surrounded and covered them, and beneath which the rock was seen to be mostly of a soft mottled sandstone in horizontal beds, as in that particular pit near which they were standing. A few yards from this was a stone quarry showing the fundamental rocks lying at high angles, almost perpendicular in fact. This dissimilarity in inclination served to

establish the superposition of the mottled sandstones to the slates. The basal part was made up of sub-angular gravel, of which the auriferous cement rock of Humbug Scrub was an example. These, continued the Professor, were considered to be of fluviatile origin, and might be the terrestrial equivalents of the marine Miocenes seen at Government House quarry and Hallett's Cove. With the exception of a few shrubs, the large majority of the very varied plant species found in the neighbourhood were, in regard to duration, ephemeral. This seemed to be owing not so much to the quality of the soil as to its non-retentive property for water, and consequently there could only be exuberance of vegetable life when the surface was saturated. From these circumstances the greatest richness was about the margin of these Tertiary patches, and it was there chiefly that search for orchids would be directed.

The party then moved off in a southerly direction, and commenced to make their floral collections. This they experienced no difficulty in doing, as flowers were to be seen in great profusion wherever the eye turned. Although not the orchid-ground proper, yet some of these lovely flowers (chiefly the Caladenias) were gathered on this scrub land. That very beautiful dark-blue flower *Chaemascilla corymbosa* was also met with here. Ere long a sharp turn to the left was taken in order to reach the edges of the Tertiary patches, where Prof. Tate had indicated that orchids would be found. Such indeed proved to be the case, and several varieties were secured, viz., *Thelymitra aristata* (or *nuda*), *T. longifolia*, *T. McKibbinii*, *T. antennifera*, and last, but by no means least, *T. grandis*, which attains a height of three feet, with a spike of numerous flowers, which is seldom less than twelve inches in length. Of Caladenias the following were observed:—*C. Menziesii* and *C. Pattersoni*, with two or more of its sub-species. Other orchids collected comprised *Prasophyllum patens* (or *fuscum*), with its small white flowers; *Microtis porrifolia* (small green), *Glossodia major*, the flowers of which are of a purple colour.

Leaving the orchid ground, a course was struck for the aqueduct coming from the Torrens weir. On the way a discovery of an interesting little plant was made. This was *Calocephalus Drummondii*, a Western Australian species, but found in a few localities in this colony, its discovery in the latter having been made by Professor Tate at Highbury. The main road was now struck, and shortly afterwards the coach was reached.

The following are some of the plants found on this excursion, viz.:—*Dichopogon strictus*, *Brunonia australis*, with its bright blue spiky heads, *Chaemascilla corymbosa*, *Cheiranthera linearis* (dark blue), *Lotus australis*, *Pimelea humilis*, the thorny

Hakea rugosa, *Euphrasia Brownii*, and the very minute *Helipterum exiguum*, *H. pygmaeum*, and *Leeuenhoeckia dubia*. Worthy of mention is *Linum marginale* (native flax), which is remarkable in being at times affected by a gall, this being the only instance known in the world of a gall being found on a flax. One plant of the order Euphorbiaceæ was noticed, viz., *Poranthera microphylla*, which is a small poisonous species. Of the Leguminosæ may be cited *Eutaxia empetrifolia*, a small shrub literally covered with yellow flowers; *Dillwynia hispida* (dark red), and *Swainsona procumbens* (scarlet). Two varieties of *Vittadinia australis* (white and purple) were seen, which differed greatly in the form of leaf. These belong to the Compositæ, of which order *Podolepis rugata* (in bud only), *Leptorrhynchus squamatus*, *Senecio lautus* and *Microseris Fosteri* (native yam) were also gathered. Amongst a lot of other flowers more or less interesting may be mentioned *Velleia paradoxa*, *Goodenia geniculata* (both yellow), *Scævola microcarpa* (bluish white) *Cynoglossum suaveolens*, *Dianella revoluta* (blue), *Bulbine bulbosa* (yellow), *Thysanotus Patersoni* (a purple climber), *Calycothrix tetragona* (a delicate pink flower growing in very thick clusters), *Leptospermum myrsinoides*, and *Grevillea lavandulacea*. *Daucus brachiatus* (which is commonly called the native carrot, but which has no thickened root) was also found. This plant extends over the whole Australian continent. There were two Acacias, namely, *A. obliqua* and *A. myrtifolia*, the latter just out of bloom.

Shortly after 5 o'clock the coach left the Highbury Hotel, arriving in town about an hour later.

Sixteenth Excursion — Saturday, October 24, 1885.— Government Farm.

The first of two extra excursions arranged for the month of October was held on this date, when about forty members and friends left by the 1.10 p.m. train for Belair. On arrival there a course following the railway line in a westerly direction was first taken, Professor Tate leading the way. After walking for about three-quarters of a mile a halt was called, and a short meeting held. Dr. Cleland (Chairman of the Section) presided. Two new members were elected. The meeting over, Professor Tate stated that he wished to take the geologists to a railway cutting a little further on, and invited those who took an interest in geology to accompany them. Those who were botanically inclined he recommended to search in that portion of the scrub land of Government Farm near which they were standing, and it was arranged that both parties should subsequently rejoin each other. Accordingly the party

separated, the majority favouring the study of botany. On arriving at the cutting to which reference has been made Professor Tate explained that this was a small patch of diluvial formation, consisting of sandy clays with sharp gravel underneath, and occasionally cemented by a ferruginous layer of hard rock overlying uncomformably the decomposing sandy slates. It might be regarded as a portion of the same series as they had seen at Highbury a fortnight ago. He drew the attention of the members to the contour of our hill slopes, as being such as would not result from atmospheric denudation, which tends to bring into relief the hard bands, whereas in the case of our hills the hard and soft were smoothed down to one uniform curve. The Professor then took the opportunity of making his hearers acquainted with the last phase of the controversy touching the glaciation of Australia. As bearing on the question under discussion, Mr. D. B. Adamson referred to Croll's theory as to climatic changes being due to the shifting of the earth's axis, remarking that astronomical facts did not justify this conjecture. The geologists then continued to walk along the railway line as far as a very high embankment at the entrance to a beautiful little glen. This latter, about a quarter of a mile from the embankment, is closed by lofty walls of rock, about seventy or eighty feet high in parts, a waterfall of small dimensions flowing over the extreme end. To this the party wended its way, and on arriving there the formation of waterfalls was discussed. It was pointed out that in the case of the one before them, the walls of which were composed of grit-bands, a very large mass of rock must have been washed away, and that the present flow of water was not competent to have caused this. As the erosive action progresses the waterfall itself continues to gradually lessen in height because of the inward high dip.

Mr. J. G. O. Tepper acted as guide to the botanical party, who directed their energies to that portion of Government Farm which had been recommended. The most striking feature here was the shrub *Leptospermum myrsinoides*, which was covered with its white flowers, suggestive of a fruit blossom. Attention was directed to the female pistillate flowers of the *Casuarina distyla*. This part of the hills is noted for its orchids, and several varieties were gathered. A very interesting discovery of an orchid not previously found in these parts was also made, viz., *Calochilus Robertsoni*, which is met with in the South-East, and two years ago was seen at Maclaren Vale, but previous to the date of this excursion was not known at Government Farm. A remarkable feature of this orchid is its lip, which is covered with dense hair, and presents a most peculiar appearance. Other orchids found during the afternoon were *Thelymitra*

longifolia, *T. antennifera*, *Microtis porrifolia*, *Prasophyllum patens*, *Pterostylis barbata*, *Caladenia Menziesi*, *C. dilitata*, and *Glossodia major*, three distinct colours of the last-named being noticed, including a pure white one. Two or three kinds of Droseras were seen, and their insect food pointed out. Those very minute flowers *Stylidium despectum* and *S. calcaratum* were gathered. The latter of these, in some points, is not unlike the *Polypompholyx tenella*, which is supposed to be carnivorous, and contains a sweet secretion which is thought to lure insects to their destruction. *Isopogon ceratophyllus*, *Helichrysum scorpioides* and *H. Baxteri* were collected. Growing near a watercourse were the small pink *Lythrum hyssopifolia* and the native flax (*Linum marginale*). The pink *Erythræa australis*, which in the summer months is seen in abundance in many parts of the colony, was already in flower, and is noted for its tonic properties. A little way up the glen was seen a rich bank of maidenhair fern (*Adiantum æthiopicum*), and in a short time the waterfall was reached, where the other party were enjoying a rest, and in which they were now joined by the botanical section. On discussing results Professor Tate reported that he had found a very rare plant, viz., *Euphrasia scabra*, which is an annual, and very local, this being the first time the Professor had met with it. Near the waterfall the rarer plants noticed were *Verbena officinalis*, *Siegesbeckia orientalis*, *Cynoglossum suaveolens*, and *C. australis*. When their energies had been sufficiently recruited the whole party started on the homeward journey, following much the same course as that by which the botanical division had come. Returning to the pasture-land, *Brachycome diversifolia*, *Ajuga australis*, and *Pultenea pedunculata* wers collected, while the banks were gay with the white Stichwort (*Stellaria glauca*). One or two members, who had not gone as far as the others, had found *Veronica Derwentia*, which had not been met with by the rest of the party. On the way back the sedge (*Schœnus Tepperi*), discovered by Mr. Tepper on Yorke's Peninsula, was noticed. Amongst other flowers not previously mentioned which were gathered may be noted *Dillwynia hispida*, *Tetratheca ericifolia*, *Euphrasia Brownii*, *Lavatera plebeia*, *Brunonia australis*, *Cheiranthera linearis*, *Scævola microcarpa*, and *Burchardia umbellata*.

The party reached the Belair Station in time to leave by the 5.36 train, having spent a very enjoyable afternoon.

SEVENTEENTH EXCURSION—SATURDAY, OCTOBER 31, 1885.—STONYFELL.

This day, like several of the previous dates fixed for excursions, proved exceedingly wet; but notwithstanding this 20

members and friends proceeded to Stonyfell, leaving by the 2 p.m. car for Burnside. Just after reaching the Burnside-road, and opposite the house of Mr. J. Stuart Sanders, the car stopped, and guided by Mr. J. G. O. Tepper, the party turned into an open section on the eastern side of the road, and started on their walk in the direction of the hills. They had not proceeded far when a spring was noticed, around which were growing various forms of vegetation. Whilst examining this Mr. J. S. Sanders, who had espied the party from his house adjoining the section in which they were walking, came up and invited them to go into his grounds. He mentioned that the spring near which they were standing was running all the year round. Professor Tate explained that this was due to its gravel bed resting on a subsoil of clay which retained the water, the clay being coterminous with the edge of the spring. Around the spring were found the following plants:—*Stylidium despectum*, *Cyperus tenellus*, *Tillæa macrantha*, *Juncus cæspititius*, and *Scirpus riparius*. Mr. Sanders then showed the party over his extensive and well-kept garden. A portion of Mr. Sanders's property is still kept in its natural state, and several indigenous flowers were gathered there, amongst others *Helipterum dimorpholepis*, *Grevillea lavandulacea*, *Hibbertia densiflora*, *Velleia paradoxa*, *Dianella revoluta*, *Linum marginale* (native flax), and *Calycothrix tetragona*. The shrub *Bursaria spinosa*, was also noticed, but its usual characteristic, the spines, was absent. Before leaving the grounds of Mr. Sanders a short meeting was held, and a new member elected. A hearty vote of thanks was passed to Mr. Sanders for his kindness to the Section. The party then continued the walk up the slope, where the following were collected, viz., *Styphelia humifusa* (the cranberry), *Isoetopsis graminifolia*, *Calocephalus Drummondi*, *Podolepis Siemssenia*, and *Ptilotus erubescens*. A somewhat rare plant found here was *Goodenia amplexans*, which also grows at Hallett's Cove and one or two places in the Mount Lofty Range. After crossing the road at the back of Mr. Newland's house, that tertiary patch of country was reached to which Mr. Tepper recently referred in a paper read before the Section. The drift material seems to extend higher up the slopes here than at any other part along the range. This particular place is perhaps the nearest to town, and the most accessible site for obtaining similar plants to those growing on the higher elevations of the Mount Lofty Range. Some of those, also, that are met with here are not found on any other part of the range. When ascending this hill a shower of rain detained the party for some time, during which they took shelter behind some small gums (*Eucalyptus leucoxylon*). This gave an opportunity for calling attention to the *Eriogasta*,

one of the *Coccidæ*, which attacks these trees, and was seen in thick clusters on the branches. This parasite is a favourite article of diet with ants, which extract nourishment from a small hole in the shell which surrounds it. The ants, however, do not kill the *Eriogasta*, and the tree eventually dies. The rain over, the walk was resumed, and soon Stonyfell was reached, on the right of which is a quarry and on the left Mr. Crompton's vineyard. A road has been made as far as the quarry, beyond which the hill is exceedingly wild and rugged, and progress very difficult. The most noticeable botanical feature about here on Saturday was *Prostanthera Behriana*, the beautiful flowers of which excited great admiration. After careful search *Anthocercis angustifolia* was found, a plant which is restricted to only a few localities in South Australia and is found nowhere else in the world. Other plants collected at Stonyfell were *Dodonæa viscosa*, *Grevillea lavandulacea*, *Pimelea humilis*, *Pultenæa acerosa*, *Acacia continua*, *Senecio hypoleucus*, and *Ixodia achilleoides*, the last-named being the small white flower which is used for making funeral wreaths. After a short rest amidst the picturesque scenery at the head of the gully, the party walked back to Kensington, returning thence by tramcar to the city, which was reached about 6.30.

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EVENING MEETINGS.

First Evening Meeting—Tuesday, May 19, 1885.

On this evening Mr. J. G. O. Tepper, F.L.S., was to have read a paper on "Local Orchids," but owing to the small attendance the reading was postponed till June 23.

Mr. Somerville brought for exhibition a specimen of a resinous substance which exudes from a species of grass-tree found in New South Wales (*Xanthorrhæa hastilis*), and which it was thought might become a useful article of commerce. It was mentioned that a shipment of it had been sold in London for six shillings and seven shillings per hundredweight, and that a somewhat similar exudation had been noticed by Prof. Tate, F.G.S., F.L.S., on Kangaroo Island.

Second Evening Meeting—Tuesday, June 16, 1885.

There was a good attendance; Professor Tate, occupied the chair. Four new members were elected. Mr. W. E. Pickels (the Secretary), who was one of the founders of the Section, tendered his resignation on the ground that his frequent ab-

sence from town interfered with his duties. His resignation was accepted with regret, and a motion to that effect was carried. The resignation of Mr. G. F. Hussey as a member of the Committee was accepted in similar terms, and Messrs. W. J. Sowden and G. G. Mayo were elected to fill the vacancies in the Committee. Mr. W. H. Selway, jun., was elected Hon. Secretary.

The Chairman brought under the notice of the Section a periodical started by Mr. Joseph Wing in Victoria, and called the *Southern Science Record*, which he strongly recommended.

The Chairman stated that no representative of *Cordiceps* or *Torrubia* (vegetable caterpillar) is recorded for South Australia, but in digging at Nairne he found what he believed to be a *Cordiceps* parasitic on the larva of a beetle, and this he exhibited.

Mr. Tepper said he believed a *Torrubia* of a large size, some four inches long, occurred near Alice Springs.

The Chairman also showed some specimens submitted to him by a gentleman in Tasmania, who believed them to be slugs. They have a general resemblance to the liver-fluke, but there are two little tentacles springing from the upper surface. He could not claim them as slugs, but thought they might turn out to be land *Planaria*.

Mr. G. Beazley, the Museum taxidermist and articulator, then gave some practical illustrations in the art of preparing birds for stuffing.

THIRD EVENING MEETING—TUESDAY, JUNE 23, 1885.

Mr. G. Collis presided. There was a small attendance. Mr. Grasby exhibited about forty-four varieties of mosses and lichens from the banks of the River Onkaparinga at Oakbank. They were collected by the local school children in the course of an outdoor excursion under the guidance of Mr. Grasby.

Mr. Tepper exhibited a lampglass with marks upon it, giving it the appearance of being cracked, when in reality it was perfectly sound. The seeming flaws were in his opinion formed either by minute fungi or the action of saline matter from the dampness of the straw in which the glass was packed. Mr. Tepper then gave his lecture on "Local Orchids," and, with the assistance of diagrams, explained the peculiar nature and beauties of the plants, pointing out the structure of the flowers, which in all their multifarious variety exhibited the same general ground plan. He said there were thousands of species distributed over almost the whole land surface of the earth. In Australia 255 species in forty-six genera were recorded by Sir F. von Mueller, of which seventeen, with fifty-three species,

were noted from this colony, but probably more existed. Some forty-nine species and varieties have been collected by Mr. Tepper in the neighbourhood of Adelaide, chiefly about Clarendon. A short discussion ensued, and Mr. Tepper mentioned the localities where different varieties of orchids could be found, such as Stonyfell, Clarendon, Kensington, and Government Farm, and he said sandy deep ground was favourable to the flower.

Fourth Evening Meeting—Tuesday, July 14, 1885.

Professor Tate occupied the chair. There was a moderate attendance. One new member was elected. Dr. Magarey exhibited some shells. Professor Tate gave the names as *Obeliscus brunnea*, a rather rare shell, from Glenelg; *Anatina gracilis* and *Marcia faba*, from the mouth of the Onkaparinga; and *Columbella bidentata* and *Mitra Tatei*, from Salt Creek; the first had not yet been catalogued as a South Australian shell. Mr. J. G. O. Tepper showed an interesting collection of South Australian seaweeds. Professor Tate showed fossil teeth of *Ceratodus*, found in the central lake region of Australia, associated with remains of the *Macropus atlas*; a toe and bones of an emu-like bird, crocodilian remains, and part of the bony carapace of the turtle. It seemed highly probable that the fish belonged to the same species as that living in Queensland, *C. Fosteri*. In 1872 Mr. Krefft found the teeth of the *Ceratodus* in the conglomerate in the basin of the Condamine River, in North Queensland, which he considered to be of an extinct species, and last year Mr. De Vis, curator of the Brisbane Museum, found specimens in another locality, and considers that they are not different from the living species. Professor Tate thought from these evidences that his speculations on the existence of a large fresh-water area in Central Australia were proved to be correct.

Mr. W. Howchin, F.G.S., then read a paper on "Storms and Weather Charts." The lecturer dealt with the construction and uses of the barometer, with special reference to its application to meteorological science. The laws regulating storm phenomena were explained by means of the blackboard, and large diagrams were used to illustrate the hydrography and principal storm tracks as observed in Australia. The isobaric lines and signs used in the delineation of weather charts were interpreted, and some useful observations were given bearing upon Australian climatology. The storms which occur over the southern half of Australia, the lecturer remarked, almost invariably pass from west to east, first making themselves felt in Western Australia, skirting the coast with their centres well off the

land, and pass over Tasmania and New Zealand. The gathering area of these storms is probably the southern portions of the Indian Ocean, following the lines of atmospheric currents and condensation of vapour, they impinge on the south-western limb of the continent, where they are turned southwards by the anti-cyclonic conditions which normally prevail on the land. Hugging the shore they pass eastwards, and usually gather intensity as they approach the eastern limits of the continent, probably reinforced by aqueous currents flowing southwards along the eastern coastline. This intensifies the barometrical depression, whilst the area of the storm widens out, heavy gales are experienced in Bass Strait and over the adjacent coasts, spending their greatest force upon Tasmania and New Zealand. A few of our storms come up from the Southern Ocean, or have a retrograde motion from the east westwards, but these are very exceptional instances. The average rate at which storms travel may be given as about sixteen miles an hour, or 400 miles in the twenty-four hours. But this is a very uncertain feature. A storm centre may hang over a given region for several days together, or it may move forward, slowly or rapidly, without any apparent cause for such irregularity of movement. It generally takes from two days to a week for a storm to pass from the Leuwin to Adelaide, and about twenty-four hours more to reach Melbourne. The diameter of storms is seldom under 600 miles from lip to lip of the depression, but they are often vastly larger, taking in the whole of Europe, or stretching from Australia to New Zealand in one vast turmoil of wind and rain. They die a natural death by the filling up of the barometrical depression, but this sometimes does not take place until they have travelled more than half round the world. A short discussion ensued, in which the lecturer was asked to explain some points, and amongst them how it was that the readings of the barometer in South Australia did not show such extremes as in Great Britain for example. The reply was that the majority of storms which visited us had their centres well to the southward of the continent, so that Adelaide was brought only under the influence of the northern lip of the depression, where the readings of the barometer were not so depressed as nearer the storm centre.

Fifth Evening Meeting—Tuesday, July 28, 1885.

On this evening Mr. G. Beazley gave a second "Demonstration in Taxidermy." There was a fair attendance. Mr. Beazley read a paper dealing with the bony frame of birds, and explained how lightness and strength were combined in its con-

struction. The entire anatomy of the bird was described in detail, and articulated skeletons of various birds were shown in illustration of the subject. Mr. Beazley then proceeded to give a practical demonstration of the method of preparing and stuffing birds, also deer, lizard, and leopard, skins of which he exhibited. He showed a beautiful specimen of the large fish *Cossyphus Gouldii*, or blue groper, and explained the method of preparing it. A hearty vote of thanks was accorded the lecturer at the close of the meeting.

SIXTH EVENING MEETING—TUESDAY, AUGUST 18, 1885.

There was a moderate attendance. Professor Tate occupied the chair and directed attention to an exhibit of a mass of fossil oyster shells from the River Murray cliffs, and said the particular species was found in beds of three, four, and even twenty or thirty feet thick. It differed in certain particulars from the Port Lincoln oyster. He gave it the name of *O. Sturtiana*, in honour of Captain Sturt, who first recorded its occurrence at Overland Corner. The Professor also directed attention to a specimen of *Solen vaginoides*. It seemed almost confined to the north shores of Kangaroo Island, but had been found in the Port Creek, though not alive,

Professor Tate then read the following paper on

MOLLUSCAN LIFE IN ST. VINCENT GULF.

A. SURFACE LIFE.—The only species at all common is the squid *(Sepioteuthis Mauritiana)*; another cephalopod has occurred, it is *Spirula lævis*. The violet-tinted shells of *Ianthina exigua* and *I. violacea* have been taken; but on the open coastline the *Ianthinæ* and another species, *I. communis*, the delicate *Argonauta*, and a few *Pteropods* are sometimes cast up in great numbers. The majority are swimmers; the *Ianthinæ* are sustained by floats.

B. BOTTOM LIFE.—The action of the waves below the surface decreases as the depth increases, ceasing at a few fathoms. Below this surface-disturbance no movement occurs except that caused by the quiet flow of ocean currents. The molluscs exposed to the action of the waves exhibit a rich variety of adaptation of structure to the various conditions under which they live. These variations are chiefly in respect of the powers of attachment or locomotion, according as to whether the habitat is unstable or not under the attacks of waves and currents. The mollusca, in respect to habitat, or the kind of bottom on which they reside, may be considered under the following heads:—(1) Those which live between tide-marks in bays and

estuaries sheltered from wave disturbances; (2) those which live on the seashore exposed to wave and tidal action; (3) those living at the sea-bottom outside the tidal strand. The species are not only restricted in their range in depth, but also in respect to habitat in accordance with their structure.

Littoral Life.—1. Mollusca living between tide-marks in sheltered bays and estuaries.—Exemplar stations are the Port Creek and the estuary of the Onkaparinga. The tidal strand is here usually composed of mud often clothed with a green mantle of Zostera; whilst pools at the upper limit of the tide furnish a vegetable growth of *Lepilæna Preissii*, amongst which live *Pomatiopsis striatula*, *Tatea rufilabris*, *Bithynella Victoriæ;* whilst at the extreme upper limits of ordinary tides, sheltering under *Salicornia*, *Suæda*, *&c.*, the pulmonates *Ampullarina Quoyana*, *A. fragilis*, *Alexia meridionalis* and *Pythina ciliata*; and *Risella melanostoma*, *Assiminea sp.* Between tidal-marks the majority of the gastropods are vegetable feeders—*Bittium granarium*, *B. Lawleyanum*, *B. turritum*, *Risella melanostoma*, *Trochochocolea tæniata*, *Acmæa conoidea.* The only common carnivorous gastropod is *Tropon australis.* Here is the chief habitat of the bivalves *Tellina deltoidalis*, *Anapa cuneata*, *Chione aphrodina* and *Modiola flavida*—the three former burrowing by means of their foot, the last formiug a nest for itself in the soft mud.

2. Mollusca living on the tidal strand of the exposed coast.—These may be considered under two heads, viz., *(a)* Those living on rock or other firm foundation, and *(b)* those living in sand or mud.

(a) Those living on rocks. The methods by which they resist the attacks of waves are various, some of which are well known. Examples of permanent attachment are the oyster and mussel, of temporary attachment, the limpet and chiton, and of boring, the pholas. In addition, there is a large number deficient in powers of attachment, which find protection from the waves by secreting themselves under large flat stones or in rocky crevices. Living on rock, as it were between air and water, and where moistened only by the spray of the breakers, occur the pulmonate snails *Marinula patula* and *Truncatella scalarina*, and the branchiferous snail *Littorina Mauritiana;* whilst the minute bivalve *Lasea rubra* nestles in crannies of the rock-face. The gastropods living on rocks exposed to breakers have almost without exception shells of an ovate or rounded outline, shortly conical or more or less flattened—shapes best adapted to resist the action of the waves. A list of the commoner species was given. The carnivorous species are few, the commonest ones are—*Trophon Flindersi*, *Pupura succincta*, *Ricinula Adelaidensis*, *Cominella costata*, and *C. alveolata.* All

of these have considerable powers of attachment by the aid of their broad locomotive discs; their shells are excessively thick, and though not so rounded in outline as the majority of the littoral snails, yet they are not strictly elongate. An aberrant snail *(Cladopoda arenaria)* inhabits an irregularly convolute tube agglutinated by the lower half to rock surfaces. The bivalves are very few in number, and the only commonly occurring ones are *Mytilus rostratus*, *M. Menkeanus*, *Modiola australis*, which are anchored in patches or clusters by their byssal threads; amidst the mussels the little *Lasæa rubra* finds a safe dwelling. The rock oyster *(O. glomerata)* is occasionally found here, out of its usual station below low-tide mark. On flat rocky shores, as off Snapper Point, Aldinga Bay, and about Stansbury and other places on the west side of the Gulf, the cavernous depressions of the surface, and the shelter afforded by the large flattened stones, are the lurking places of many gastropods, whose shape of shell and formation of foot ill adapt them to live in exposed situations.

(b) Those living in sand. This habitat is unstable under the attacks of the waves, and no powers of attachment will serve the animal; safety lies in the quickness with which it can penetrate the sand either to avoid being washed away in the denudation of the deposit, or to force its way to the surface through any accumulation that may he piled over it. The only gastropod which habitually lives in this habitat is *Natica conica*, whose shell is smooth and subconic, not well adapted for burrowing, but offers a passive resistance to wave currents. On the ocean seaboard, where tidal disturbances are so much greater, there lives anothes species (*N. Incei*), which has a hemispheric shell. The bivalves, which inhabit this kind of deposit, have compressed valves and hatchet-like or cylindrical forms well suited for rapid penetration; whereas the globular form of shell, which is ill-adapted to force its way through a resisting medium, is unrepresented on our sandy tidal region. One of the most active in penetrating sand in which it lives is *Solen vaginoides*, having a narrow cylindrical form. All the bivalves live in long burrows, and have long siphons, which must be valuable in self-defence, more especially in the case of their young, which, from their small size, would be affected by much slighter wave disturbances than the adults, and would be in constant danger if obliged to live at the surface or close to the surface of the deposit that gave them shelter.

The little *Mesodesma elongata* resides at little depth below the surface, and nearer high-water mark than any other of the burrowing species, and is therefore particularly liable to be exposed, as is fully attested by the vast numbers displaced during gales. It burrows, however, very readily, and moves on

the surface of the sand with much expedition. Our two species of Pholads (*Barnea similis* and *B. australasiæ*) and *Venerupis obesa* burrow in stiff clay at low-water mark.

Molluscs living beyond low-tide.—Those living on rocky bottoms present no special feature from those living between tidemarks, except that a greater number of species occur, increasing somewhat with the depth. The greatest variety of life occurs undoubtedly on rocky bottoms extending to a few fathoms in depth. Here haunt a large species of *Octopus*—*Cypræa thersites*, the *Volutes*, *Ostrea Angasi*, *Pecten laticostatus*. The delicate parchment-like shell of *Avicula pulchella* anchors to the stems of seaweeds, and the delicate limpet, *Nacella parva*, creeps upon them; *Waldheimia australis* also in the same position, and fixed to other submarine bodies. *Gastrochæna Tasmanica* lives in crypts which it excavates in limestone or in the thick test of oysters.

Molluscs living on soft bottom beyond tidemarks.—In shallow water ranging to six fathoms life is very abundant, especially among the submarine pastures of *Cymodocea zosterifolia* and *Posidonia australis*, which afford secure protection against ordinary wave currents, and are the favourite haunts of the Sepias and Sepiolas among cuttlefish. Globose bivalves and slender turrited shells here only are found. It is unnecessary to enumerate the species inhabiting this region, but I may indicate some of the novelties in respect to habit. *Pinna Zealandica* lives in large colonies anchored vertically in the mud by means of its sharp apex and long byssal threads; parasitic on it are *Crepidula immersa*, *Amalthea conica*, *Placunanomia Ione*, *Hipponyx*. The delicate *Anatinas* form deep burrows; *Vulsella ovata*, *Modiolaria Cumingiana*, *Siliquaria australis*, and *S. Tahitiensis* burrow in sponges; whilst *Pecten asperrimus* is conversely the host of a soft red sponge: a species of *Eulima* lives on *Cidaris* and other echinoderms.

The waters of St. Vincent Gulf are for the most part very shallow, and little or no exploration has been carried beyond a few fathoms, except in one instance only, to my knowledge, in Backstairs Passage, whence was obtained a few mollusca, from 32 fathoms, which have not been met with elsewhere in the Gulf, and some not at all. They are *Erato lachryma*; *Cardita sp.*; *Gastrochæna lamellosa*; *Limea, n.sp.*; *Terebratulina cancellata*.

In adding a few remarks on the subject of his paper, the Professor pointed out that if the Port Creek and Largs Bay were each to be fossilized, it would be found that the common shells of the one were not the same as the common shells of the other. He did not agree with the attempts that had been made to place the various fossil localities in the Older Tertiaries

of South Australia in superposition. Dissimilarity of life did not always indicate difference of age. Some cases of fine specimens were exhibited and examined.

Mr. A. Molineux then read an interesting paper on "Methods of Exploring the Sea Bottom," in which he described various appliances used in trawling and dredging, and referred to an element of danger in the pursuit, viz., stings from various fish that are armed with poisonous barbs and spines, *e.g.*, catfish, perch, gurnet, and particularly the "cobbler" (*Apistes marmoratus*), stated that he had tried grappling-irons for the deeper waters of the passage between Cape Jervis and Kangaroo Island without encouraging success, and concluded by pointing out that when dredging and trawling are conducted for scientific purposes a great many particulars were recorded, viz., latitude and longitude; depth, temperature, and density of water; direction and force of wind; the tides; the number, species, varieties, character, &c., of specimens obtained; the time of year, and many other things.

After an expression of opinion on the desirability of further dredging operations in the Gulf the meeting closed.

Seventh Evening Meeting—Tuesday, September 15, 1885.

Professor Tate occupied the chair. There was a good attendance. One new member was elected. A number of specimens obtained on the trawling expedition of the previous evening, consisting of sponges, crustaceans, fishes, ascidianes, molluscs, and other denizens of the Gulf, were exhibited, and the President made explanatory remarks. A specimen of a rare snake—the *Hoplocephalus spectabilis* of Krefft—found at Scott's Creek, near Nairne, was exhibited by Professor Tate. The reptile was alive, and of a poisonous species, but Professor Tate stated that it was very small, and practically harmless. It was very little known. A specimen was obtained some twenty years ago in the Port Lincoln district by Mr. Masters, and he (the speaker) had found one since at Ardrossan. Mr. J. G. O. Tepper, F.L.S., showed some orchids from Kangaroo Island, comprising *Caladenia lolifolia, C. clavigera, C. filamentusa, Diuris longifolia, Liperanthus nigricanes, Prasophyllum* (sp. large-flowered), *Caladenia* (with very small flowers, perhaps new), and *Pterostylis* sp. The President announced that owing to the continued illness of Dr. Stirling, his lecture, "The Borderland of the Animal and Vegetable Kingdoms," was postponed. Mr. Molineux described in a conversational way some of the marine curiosities secured at a trawling expedition on the previous evening. A so-called native hare

(Peragalea lagotis), with a young one in the pouch, was shown by Mr. Beazley; it came from Orroroo.

Annual Meeting—Tuesday, October 13, 1885.

There was a fair attendance. Four new members were elected. Along one side of the room was arranged a fine collection of New Zealand ferns by Mr. J. G. O. Tepper, F.L.S. There were exhibited on the table a number of specimens obtained on trawling expeditions, and they were briefly noticed by Prof. Tate, who named a cuttlefish as *Sepia brevimanus*, so called from the short arms. The largest size he had met with was thirteen inches. A great novelty presented was the young of the Echidna. The Professor also described a tray of interesting shells; also some orchids (submitted by Mr. Tepper) which were not of any recorded species.

Professor Tate said the work of the past year had not been of such an encouraging kind as could have been desired. They had had a good deal of lecturing during the winter evenings, but the Society had not progressed. That might arise from the novelty wearing off, but those that remained were the ardent students. In comparing the work done by this Section with that done by a similar Society in Melbourne, he might say that the field excursions here were better attended than those of the Melbourne Field Club, but on the other hand the night-work over there was far in advance of ours. There was always a long list of exhibits drawn from all parts of the world, and generally an indication of better work by the students. The excursions here had been comparatively well attended, but the evening meetings poorly so. Perhaps the members had lost sight of the real object of the evening meetings, which was to supplement the knowledge gained at the excursions. Although he ceased to be Chairman he would ever be ready to show as active an interest in the Society as heretofore. The Secretary then read the following:—

ANNUAL REPORT OF THE COMMITTEE.

"In submitting the second annual report of the Section the Committee are pleased to be able to regard the year's proceedings as on the whole of a satisfactory and encouraging nature.

"The novelty attaching to the inauguration of the Section (it being an entirely new feature for the colony) has now had time to wear off, and, although the large gatherings at the first few meetings have not since been equalled, the attendances this year, especially at the whole-day excursions, have been well sustained.

"Five whole-day and ten half-day excursions were arranged for during the year, a new departure having been instituted in fixing outdoor meetings in the winter as well as summer months. Owing to the unfavourable state of the weather, however, on the days fixed for Saturday afternoon excursions in the months of May, June, July, and August those meetings virtually fell through, proposed visits to the Botanical and Zoological Gardens being amongst the number.

"Seven evening meetings have been held most of iwhich were fairly attended. On two of these occasions demonstrations in taxidermy were given by Mr. G. Beazley with the kind permission of the Museum authorities.

"In the month of May, 1885, the Committee received with great regret the resignation of the Honorary Secretary of the Section, Mr. W. E. Pickels, F.R.M.S., on account of his removal to another colony. The Committee desire to express their sense of the loss sustained by the Section in consequence of this step, and their appreciation of the energy and ability with which Mr. Pickels conducted its affairs.

"A by-law has been passed by the Section requiring Fellows of the Royal Society to pay a registration fee of one shilling each if desirous of becoming members of the Section. This action has been confirmed by the Royal Society.

"Thirty members have been added to the Section during the year, but about fifty names have been removed from the roll, either on account of resignations, non-payment of subscriptions, or for other reasons. The present number of members is therefore less than at the close of last year. It is evident that very many of those whose names appeared on the roll have taken but little interest in the active work of the Section, not a few having never attended any of its meetings, and others but very seldom.

"During the year the Council of the Royal Society conferred on the Section the honour of inviting the members of the latter to be present at the meetings of the Royal Society.

"The expenses of the Section have been, as in the previous year, much greater than the receipts from subscriptions, the latter amounting to about £20, while the disbursements (chiefly for printing and postage), have been about £40. It is intended, however, to adopt a system in the coming year by which it is hoped the Section will become self-supporting.

"For the Committee,

"W. H. Selway, Jun., Hon. Sec."

Professor Tate, in reference to the report, said the expense were about double the amount of the receipts. He hoped to see a balance on the right side next year, so that there might be a surplus to set apart for awarding prizes. He would

supplement the sum to a reasonable amount. He moved the adoption of the report, which was carried.

The election of officers then took place, as follows:—Chairman, Dr. Cleland; Vice-Chairmen, Mr. J. G. O. Tepper and Dr. Magarey; Hon. Secretary, Mr. W. H. Selway, jun.; Committee, Professor Tate, Messrs. Molineux, G. G. Mayo, G. Collis, H. Dean, D. J. Adcock, D. Fleming, W. J. Sowden.

After some scientific discussion and a paper read by Mr. Tepper upon the "Geological Features of Stonyfell"—

Professor Tate stated that a testimonial had been purchased by the members of the Society for the late Secretary, Mr. Pickels.

The testimonial, a handsome gold chain and locket, the latter suitably inscribed, was handed over to Mr. G. Collis, who responded for Mr. Pickels, and undertook to forward it to that gentleman.

OFFICERS.

CHAIRMAN:

Mr. W. L. Cleland, M.B.

VICE-CHAIRMEN:

Mr. J. G. O. Tepper, F.L.S.
Mr. S. J. Magarey, M.B.

COMMITTEE:

Professor Tate, F.L.S., F.G.S.
Mr. A. Molineux.
Mr. G. Collis, jun.
Mr. H. Dean.
Mr. D. J. Adcock.
Mr. G. G. Mayo.
Mr. W. J. Sowden.
Mr. D. Fleming.

HON. SECRETARY:

Mr. W. H. Selway, jun.

FIELD NATURALISTS' SECTION OF THE ROYAL SOCIETY OF SOUTH AUSTRALIA.

BALANCE-SHEET, 1st OCTOBER, 1885.

1884.	Dr.	£	s.	d.
Oct. 22.	Balance in hand	5	12	0
1885.				
May 17.	Grant from Royal Society of South Australia..	20	0	0
Sept. 24.	" " " ..	35	0	0
		£60	12	0

1884.	Cr.	£	s.	d.
Nov. 2.	Secretary, W. E. P., Cash	1	0	0
Dec. 1.	" " "	1	0	0
Jan. 10.	" " "	1	0	0
Jan. 24.	" " "	0	10	0
Feb. 18.	" " "	1	0	0
Mar. 10.	" " Postages	8	0	0
Mar. 15.	" " Cash	1	10	0
Mar. 19.	Sherring & Co., Printing	15	1	6
June 30.	Geo. Beazley, Expenses	1	8	9
Sept. 24.	Sherring & Co., Printing	22	16	0
Sept. 30.	Handed to Treasurer Royal Society ..	7	5	9
		£60	12	0

Audited and found correct,

WALTER RUTT,
LIONEL C. E. GEE } Auditors.

W. H. SELWAY, Jun., Hon. Sec.

Adelaide, 30th September 1885.

LIST OF MEMBERS

OF

FIELD NATURALISTS' SECTION

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA

AT DATE OF ANNUAL MEETING, OCTOBER 13, 1885.

Those marked † are Fellows of the Royal Society, S.A.
Those before which the letter F appears are foundation members.

†FAdamson, Mr. D. B., Angas-street, Adelaide.
FAdcock, Mr. D. J., Currie-street, Adelaide.
Addison, Mr. H. M., King William-street, Adelaide.
FAitken, Mr. J., Parkside.
Anderson, Mr. T. G., N.E.-road, Medindie.
FBaker, Mr. W. H., 34, King-William-street.
Beazley, Mr. Geo., The Museum, Adelaide.
†Beresford, Mr. D. J. D., Parliament House, Adelaide.
Best, Mr. D. (Hon. Memb.), 16, Little Collins-street E., Melbourne.
Bevilaqua, Mr. L. W., Fullarton.
FBeythein, Mr. E., Moonta.
FBishop, Mr. J. F., Union Bank, Adelaide.
FBottomley, Mr. W. D., Savings Bank, Adelaide.
FBoulger, Professor, University, Adelaide.
Bowen, Mr. F. C., Freeman-street, Adelaide.
Brook, Mr. W. J., J.P., Pirie-street, Adelaide.
Bruce, Mr. J., Architect-in-Chief's Office, Adelaide.
†FBruer, Mr. J. J., King William-street, Adelaide.
†Bussell, Mr. J. W., F.R.M.S., Railway Station, Adelaide.
Chipp, Mr. H. E., Currie-street, Adelaide.
†FCleland, Dr. W. L., Parkside.
Cleland, Mrs. W. L., Parkside.
FCollis, Mr. G., jun., Gawler-place, Adelaide.
Coppen, Mr. E., c/o Mrs. Symes, Grenfell-street, Adelaide.
Cornock, Mr. T., The Museum, Adelaide.
FDane, Mr. F. N., Eliza-street, Waymouth-street, Adelaide.
†FDavies, Mr. E., Flinders-street, Adelaide.
FDean, Mr. H., jun., Carrington-street, Adelaide.
Dixon, Mr. S., c/o Messrs. Luxmoore & Co., Limited, Adelaide.
†FDobbie, Mr. A. W., Gawler-place, Adelaide.
Dombrain, Mr. H. A. A., c/o Messrs. Young & Smith, Waymouth-street, Adelaide.
†FEvans, Mr. T., King William-street, Adelaide.
FFabian, Mr. T., City Treasurer, Adelaide.
FFarrar, Mr. G. E., C.E., Clare.
FFleming, Mr. D., Mackinnon-parade, North Adelaide.
†FFletcher, Rev. W. R., M.A., North terrace, Kent Town.
Fornachon, Mr. C. L. F., Y.M.C.A., Adelaide.

rFrayne, Mr. N., c/o Messrs, D. & W. Murray, Adelaide.
rFrench, Rev. S., M.A., Glenelg.
rFuller, Mr. W., University, Adelaide.
†Gall, Mr. D., Tynte-street, North Adelaide.
Gallagher, Mr. W. E., Port Germein.
Gee, Mr. L. C. E., c/o Surveyor-General's Department, Adelaide.
Grasby, Mr. W. C., Salisbury.
Guest, Mr. E. (Hon. Memb.), Balhannah.
Gurner, Mr. J. R., North-terrace, Adelaide.
Hammond, Mr. H., Childers-street, North Adelaide.
rHampson, H., Leigh-street, Adelaide.
rHaslam, Mr, J., C.E., Pirie-street, Adelaide.
Hill, Mr. C., Alix House, South-terrace, Adelaide.
Hill, Mr. W. H., Quorn.
†rHowchin, Mr. W., F.G.S., Goodwood E.
Howell, Mr. F. J., H.M. Gaol, Adelaide.
Howell, Mr. Geo., Pirie-street, Adelaide.
rHunwick, Mr. Charles, Hindmarsh.
rHussey, Mr. G. F., G.P.O., Adelaide.
Jacobs, Mr. Geo. W., Currie-street, Adelaide.
Jameson, Mr. Geo. E., Union Bank, Adelaide.
Jobson, Mr. C., Hydraulic Engineer's Office, Adelaide.
Johnson, Mr. J. A., Franklin-street, Adelaide.
Johnson, Miss, "St. Catherine's," Prospect.
†Kelly, Rev. R., Mount Barker.
Kirby, Mr. E., Farina.
†Knight, Mr. G. C., Durstan House, North Adelaide.
Lawrance, Mr. V., J.P., Lefevre-terrace, North Adelaide.
Lawrance, Mr. C., Lefevre-terrace, North Adelaide.
Lawson, Mr. J. D., Divett-place, Adelaide.
rLeader, Mr. C. S., King William-street, Adelaide.
†Leary, Mr. J. L., M.A., South-terrace W., Adelaide.
Light, Mr. W., Wentworth, N.S.W.
Lindow, Mr., Messrs. J. S. Sanders & Co., Hindley-street, Adelaide.
rLock, Mr. E. H., *Register* Office, Adelaide.
†rMagarey, Dr. S. J., North-terrace, Adelaide.
Magarey, Mr. T. C., jun., Waymouth-street, Adelaide.
†rMayo, Mr. G. G., Pirie-street, Adelaide.
rMcEwin, Rev. J., *Colonist* Office, Currie-street, Adelaide.
†rMestayer, Mr. R. L., C.E., F.R.M.S., Hydraulic Engineer, Adelaide.
rMillar, Mr. A. P., Adelaide.
†rMohan, Mr. J. H., Crafers.
†rMolineux, Mr. A., Kent Town.
rMolineux, Mr. A. E., Kent Town.
†rMunton, Mr. H. St., North-terrace, Adelaide.
O'Connor, Mr. M. J., Public Library, Adelaide.
†Parker, Mr. T., C.E., St. Vincent's Chambers, Port Adelaide.
Phillips, Professor, M.A., University, Adelaide.
†rPickels, Mr. W. E., F.R.M.S., Melbourne.
Poole, Mr. W. B., Savings Bank, Adelaide.
†rPoulton, Dr. B., Adelaide Hospital, Adelaide.
Pullein, Mr. R. H., King William-street, Kent Town.
Read, Mr. Geo. A. G., Telegraph Office, Adelaide.
Robertson, Mr. J., Angas-street, Adelaide.
Robertson, Mr. W., North-terrace, Adelaide.
rRogers, Mr. A. L., 3, Rundle-street, Adelaide.
Rosenhain, Mr. O. W., Box 125, G.P.O., Adelaide.
rSansom, Mr. P., Currie-street, Adelaide.

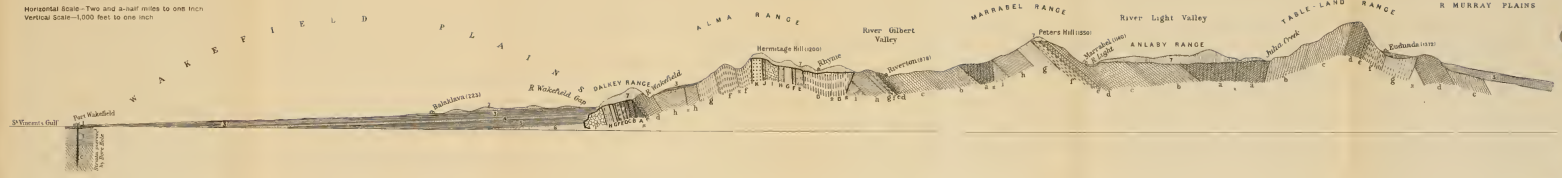
FSelway, Mr. W. H., jun., The Treasury, Adelaide.
FShapter, Mr. W. T., Public School, Gumeracha.
†Smeaton, Mr. S., B.A., Bridgeport.
†Smyth, Mr. J. T., B.A., B.Sc., Model School, Norwood.
FSowden, Mr. W. J., *Register* Office, Adelaide.
†FStirling, Dr. E. C., M.A., Lefevre-terrace, North Adelaide.
†FTate, Professor, F.G.S., F.L.S., Buxton-street, North Adelaide.
FTate, Miss, Buxton-street, North Adelaide.
Taylor, Mr. G., South-terrace, Adelaide.
†FTepper, Mr. J. G. O., F.L.S., Somerset-place, Norwood.
Thwaites, Mr. F. J., National Bank, Adelaide.
†Todd, Mr. C., C.M.G., Postmaster-General, Adelaide.
†Varley, Mr. A. K., Kirtonville, Mount Gambier.
†Wainwright, Mr. E. H., Collegiate School of St. Peter, Hackney.
Walker, Mr. A., Y.M.C.A., Adelaide.
Watts, Mr. H. (Hon. Memb.), Wellington-street, Collingwood, Melbourne.
Webb, Mr. W. H., William-street, Norwood.
FWhatham, Mr. F. G., Freeman-street, Adelaide.
FWhitney, Mr. F. M., Messrs. J. Colton & Co., Adelaide.
†FWhittell, Dr. H. T., F.R.M.S., Astor House, New Glenelg.
Wilson, Mr. I., F.E.I.S., Goodwood.
Wilson, Mr. S. P., Uraidla.
Wiseman, Mr. A., Freeman-street, Adelaide.
Witherick, Mr. J., Waymouth-street, Adelaide.
†Woodward, Mr. H. P., F.G.S., Government Geologist's Office, Adelaide.
†Wragge, Mr. C., F.R.G.S., The Observatory, Torrens Bank, Walkerville.

Stratigraphical Sketch

ACROSS THE BASINS OF THE

WAKEFIELD AND LIGHT RIVERS.

Horizontal Scale—Two and a-half miles to one inch
Vertical Scale—1,000 feet to one inch



TERTIARY GROUP.

1. Recent Marine
2. Silcrn sand
3. Drift, loam, and clays
4. Sand and gravel
5. Tough hard blue clay
6. Quicksand and gravel
7. Upland Miocene (sandstone and conglomerate)

PRIMARIES—UPPER GROUP.

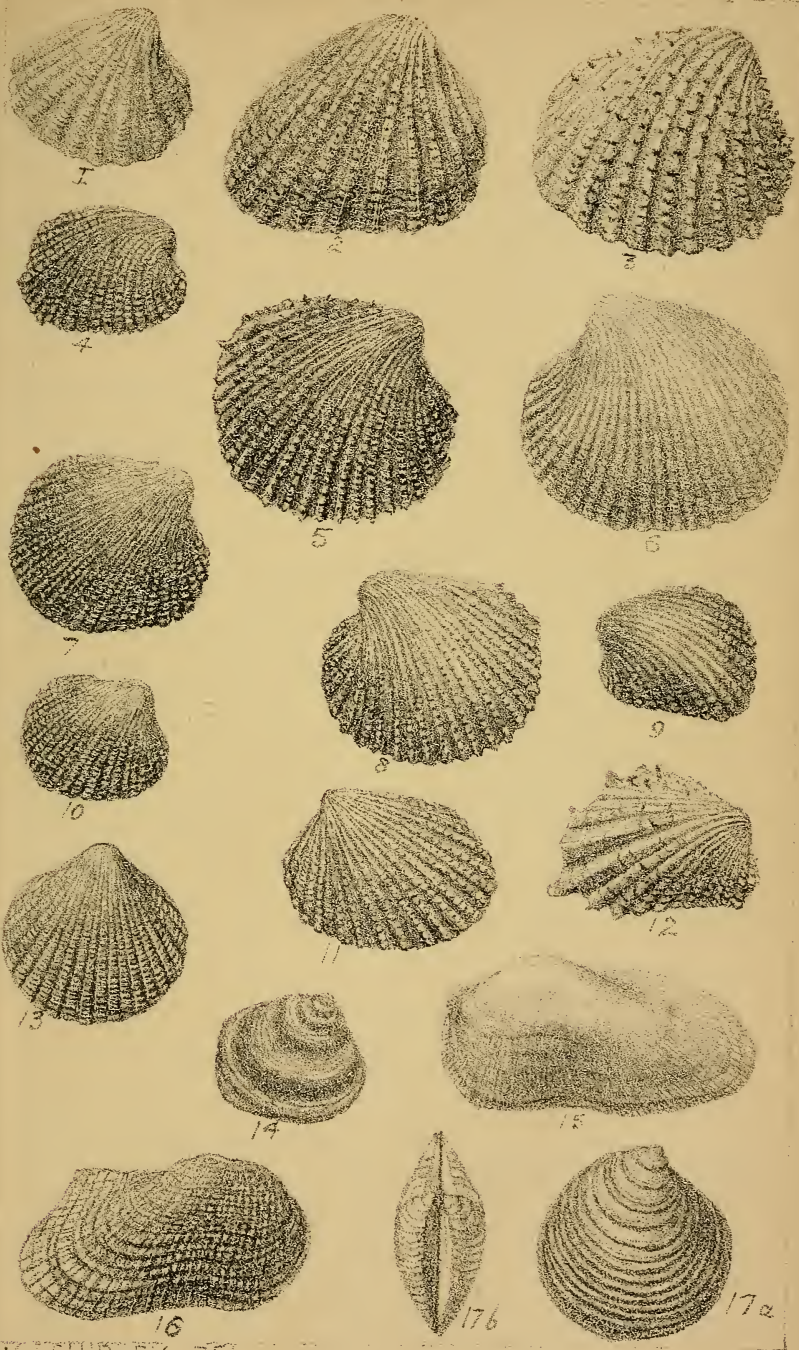
a. Greenish-grey sandy shales and soft aluminous rock
b. Pink and brown earthy slates
c. Blue slates containing black iron pyrites
d. Olive green slate
e. Brown quartzite
f. Olive green sandy shales
g. White silicy sandstones, soft and somelimes earthy
h. Blue flags
i. Silicio-grey sandstones graduating into micaceous flags

PRIMARIES—LOWER GROUP.

A. Grey talcose slate
B. Grey quartzite
C. Hard blue shale
D. Crystalline thin bedded limestone with talc partings
E. Siliceous thin bedded marbles
F. Olive-green slate
G. Brownish-white sandstone
H. Green and grey sandy slates
I. Thick bedded grey quartzite
J. Yellowish clay slate
K. Massive quartzite breccia

Faults denoted thus n
Attached figures denote height above sea level

LITHO FOR GOVERNMENT PRINTER ADELAIDE From a Drawing by Photo-lithographer



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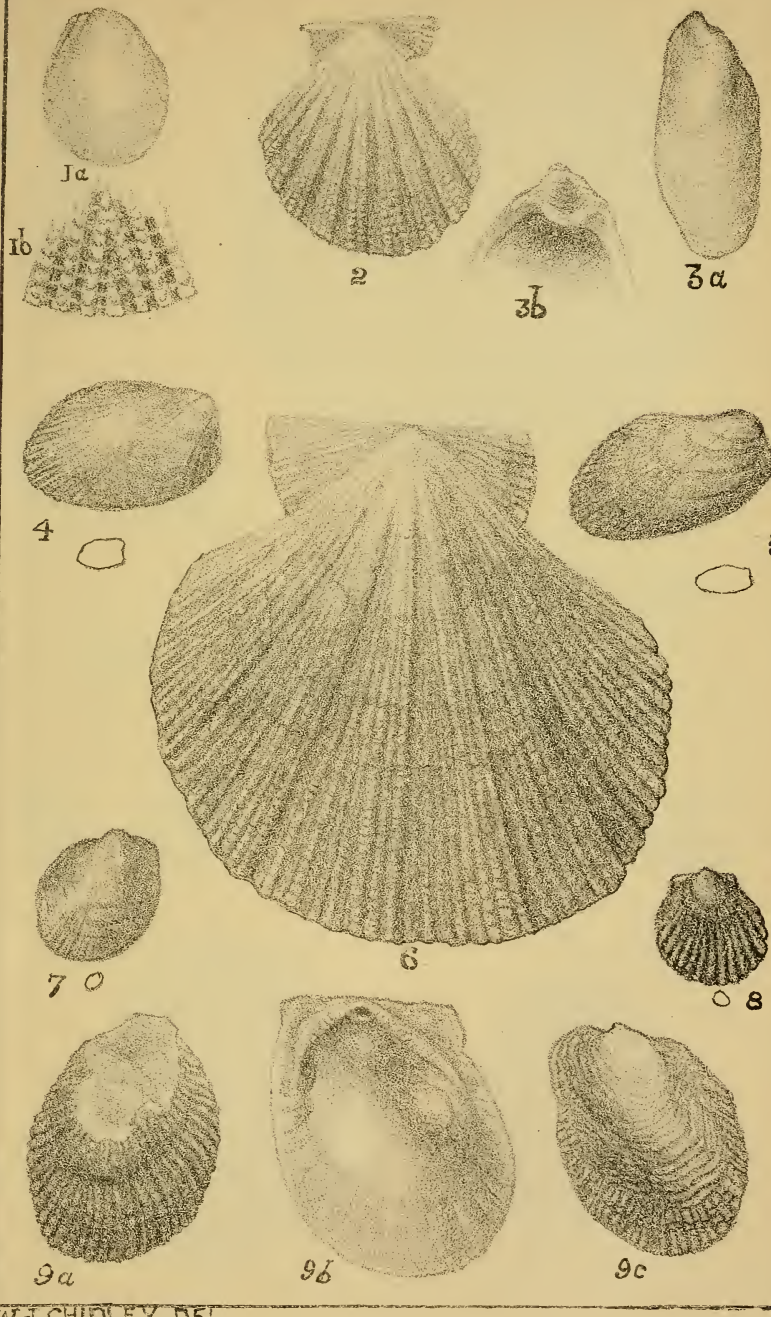

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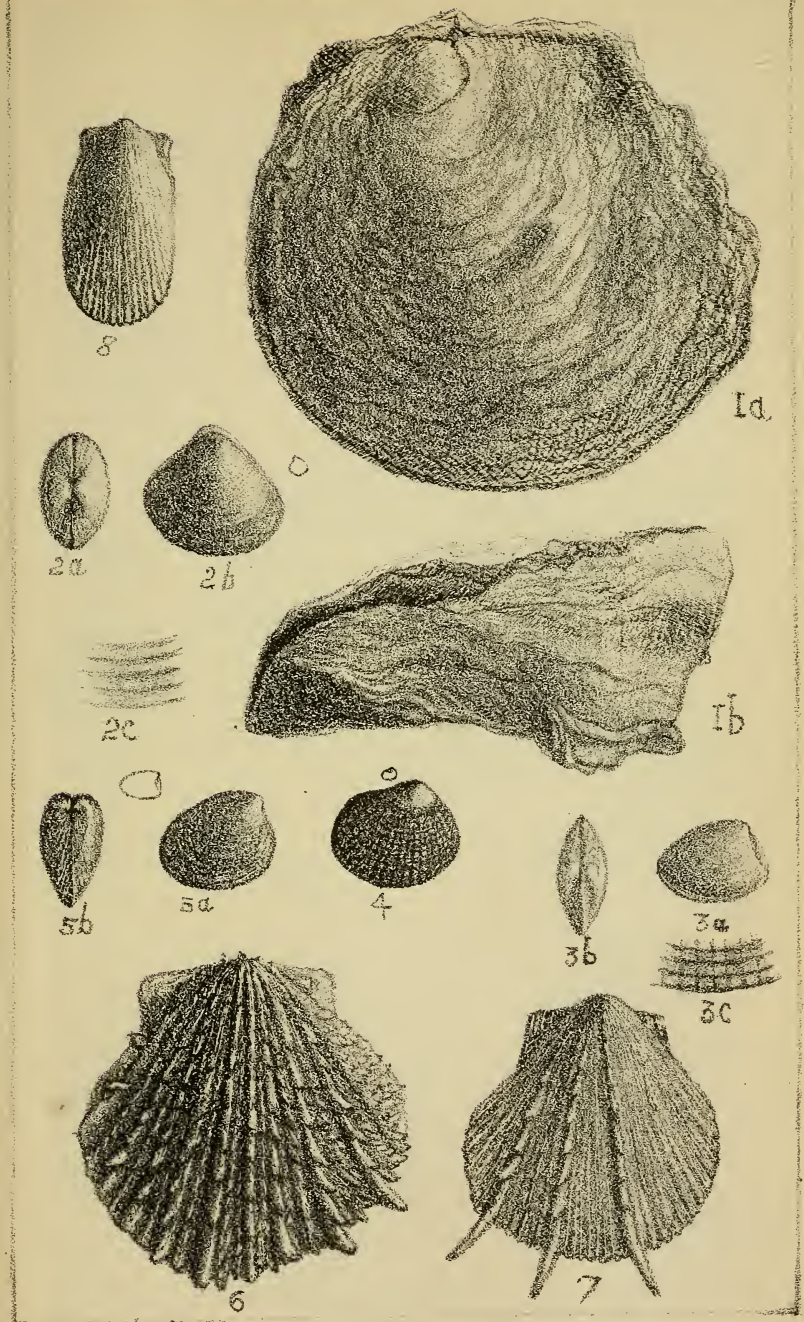

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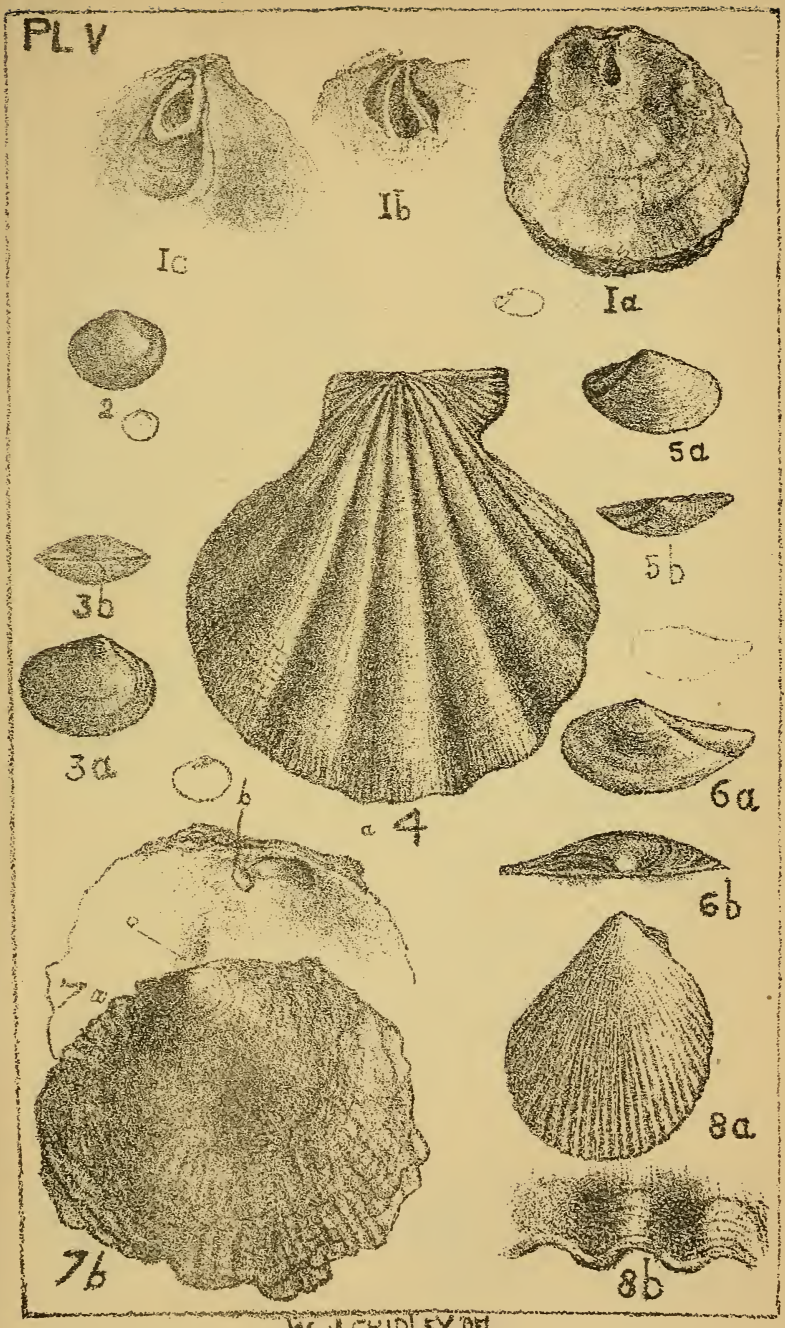
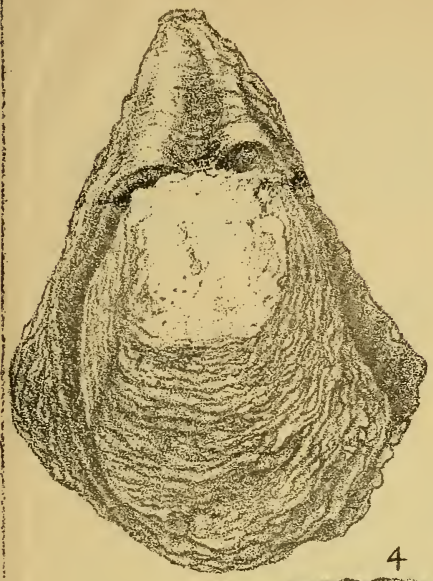


W. J. CHIDLEY DEL.

Pl. VI



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3a

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3b

3c

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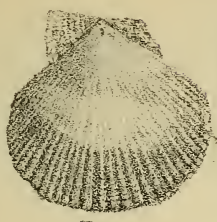
6b

7a

7b

V. J. CHIDLEY-DEL.



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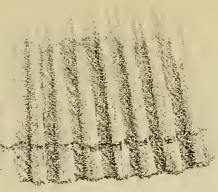

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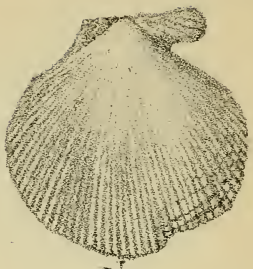

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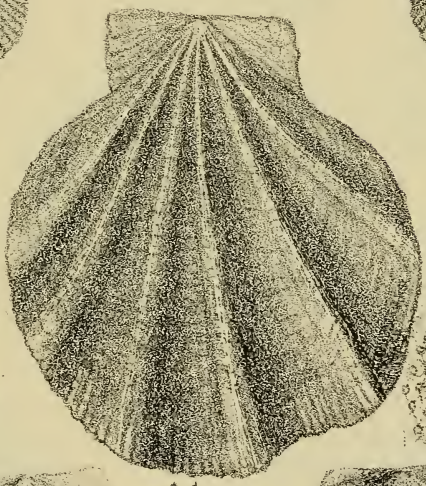

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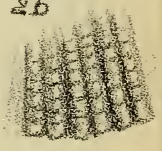

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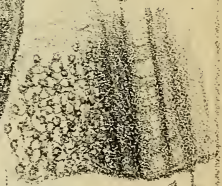

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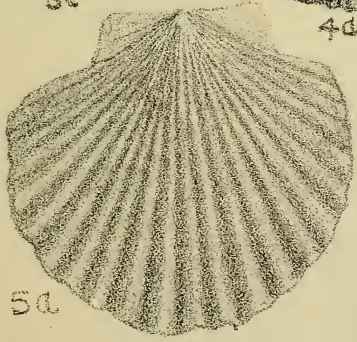

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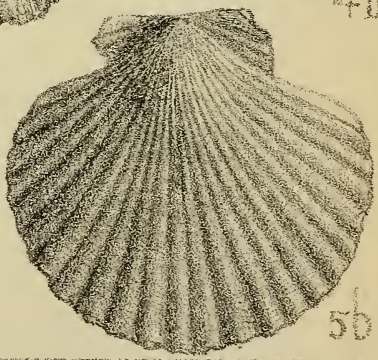

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W.A.CHIDLEY DEL.

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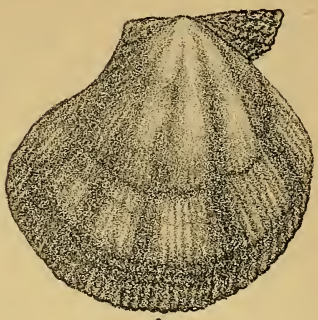

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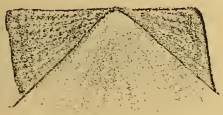

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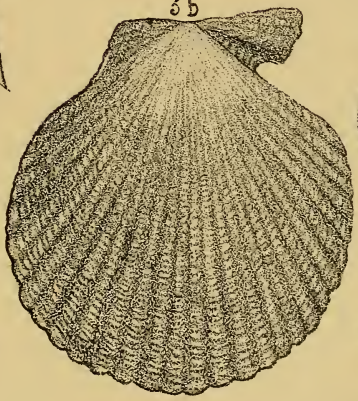

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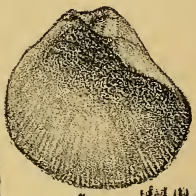

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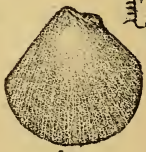

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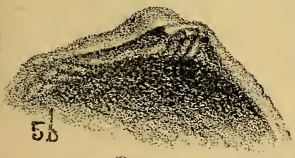

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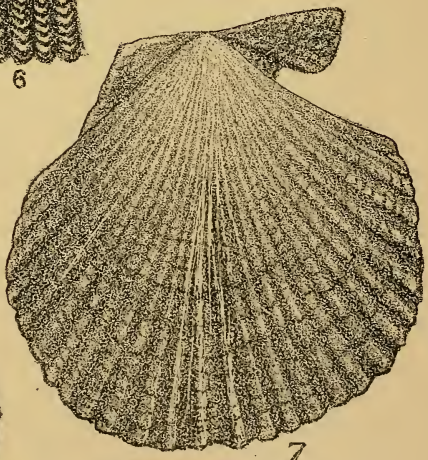

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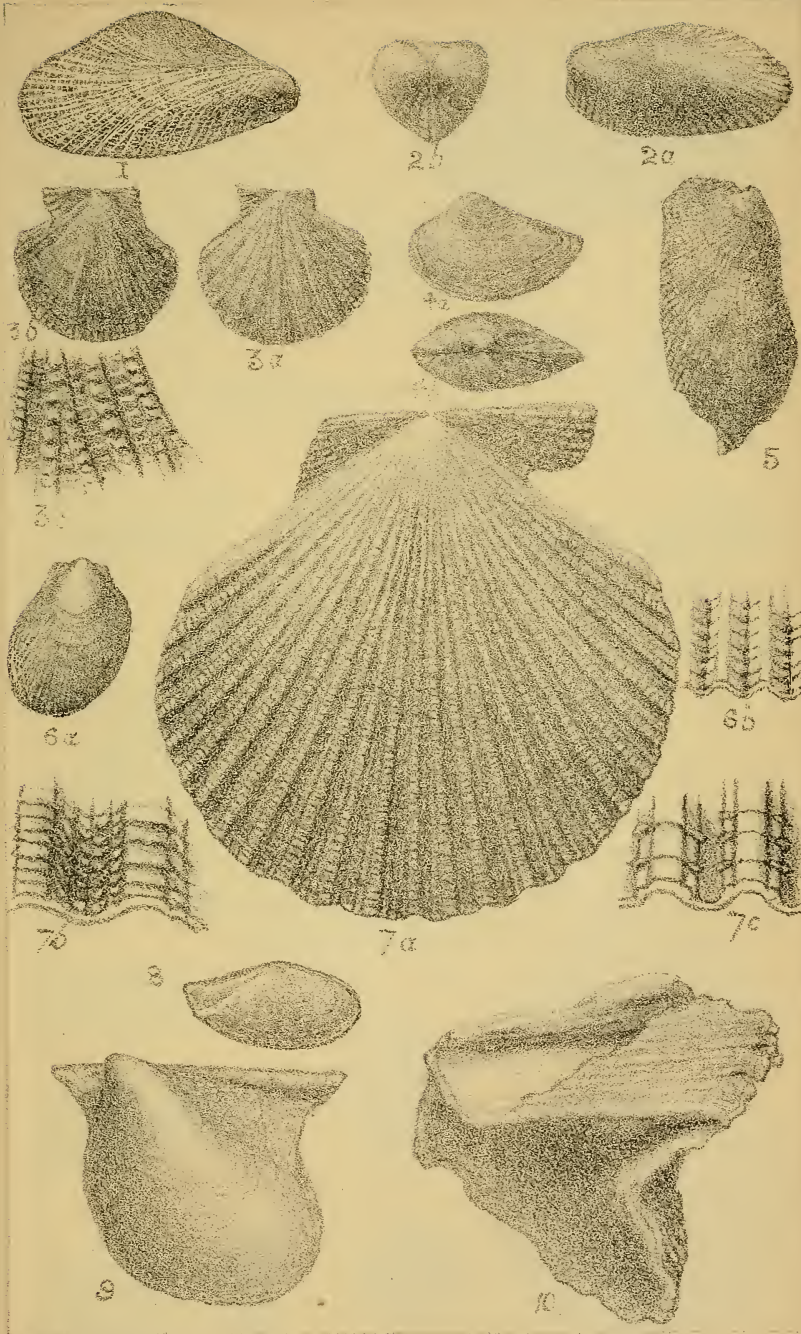

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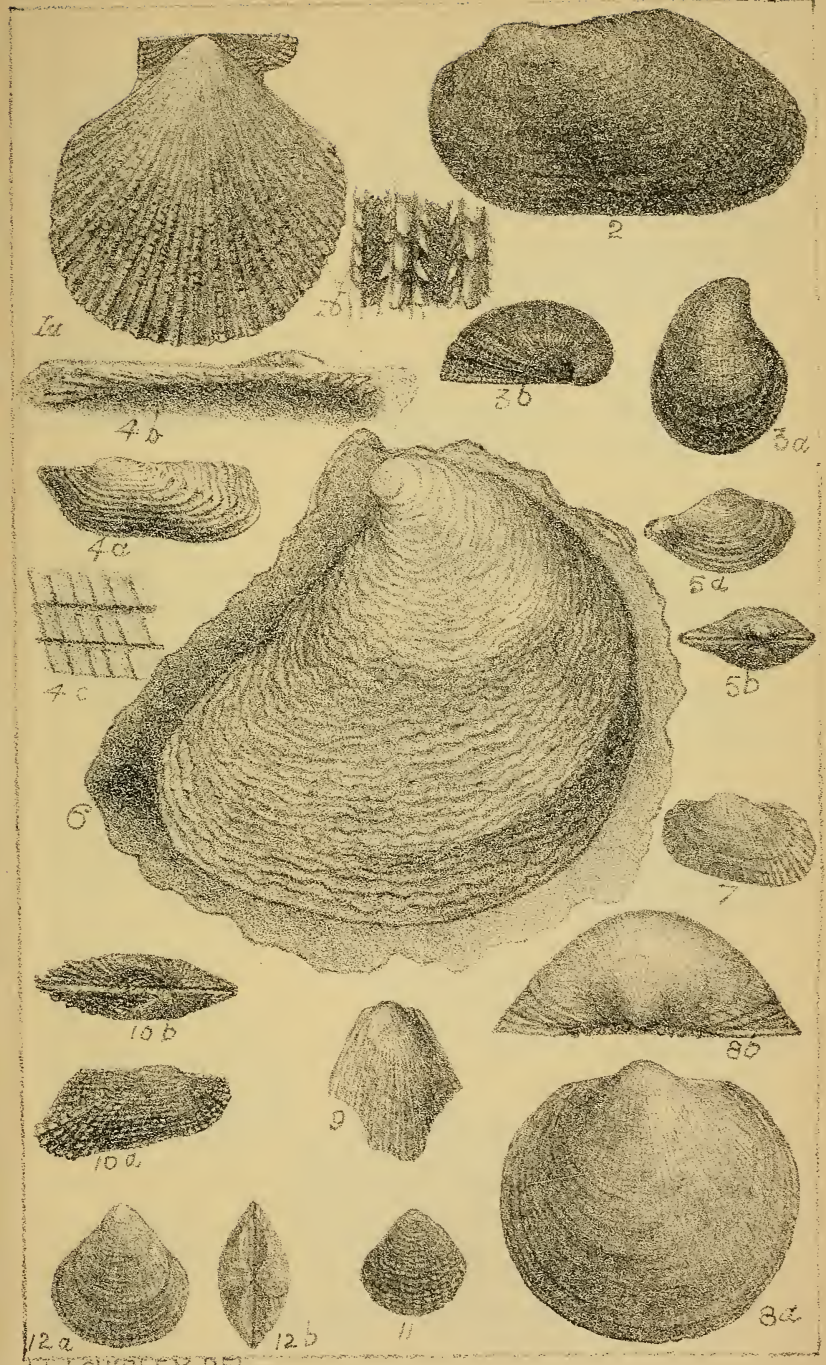

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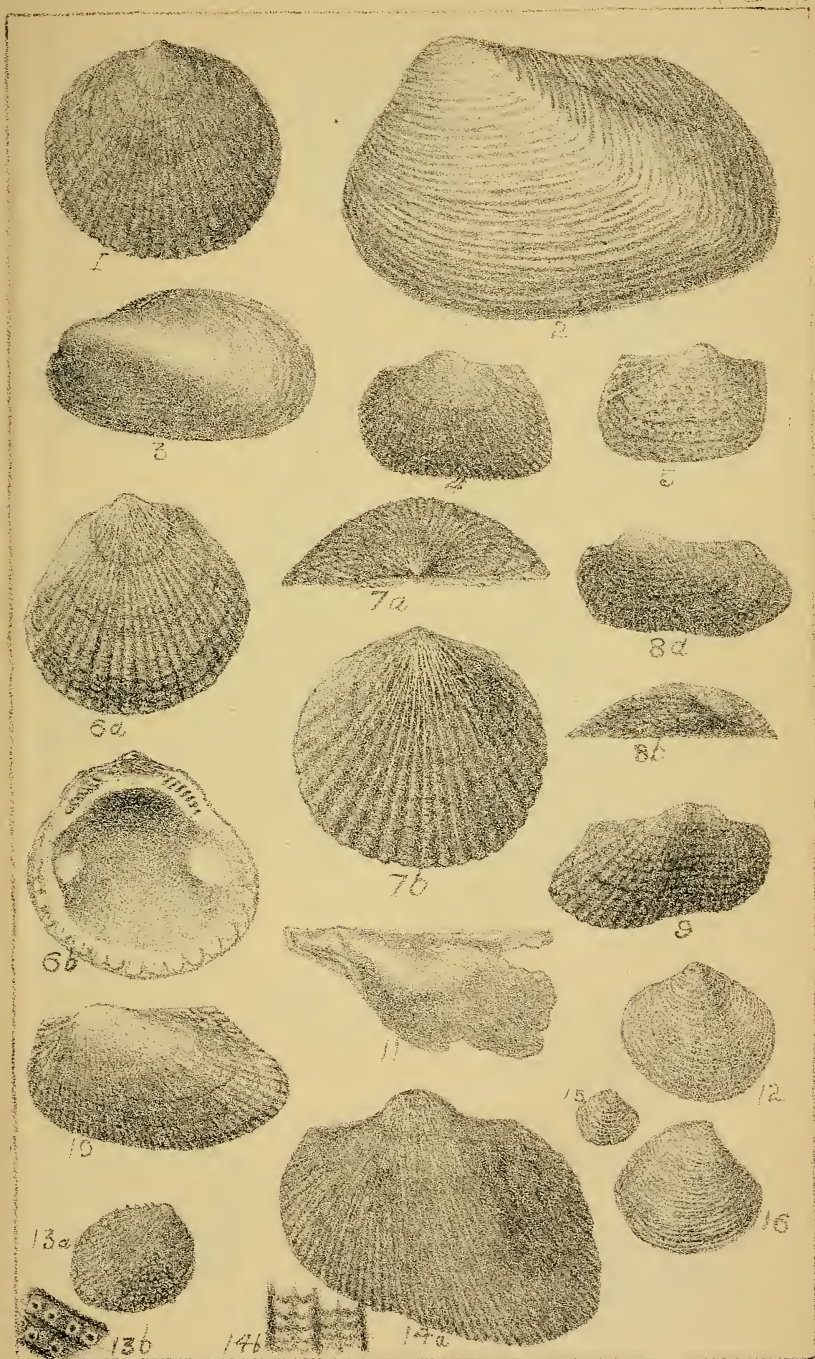

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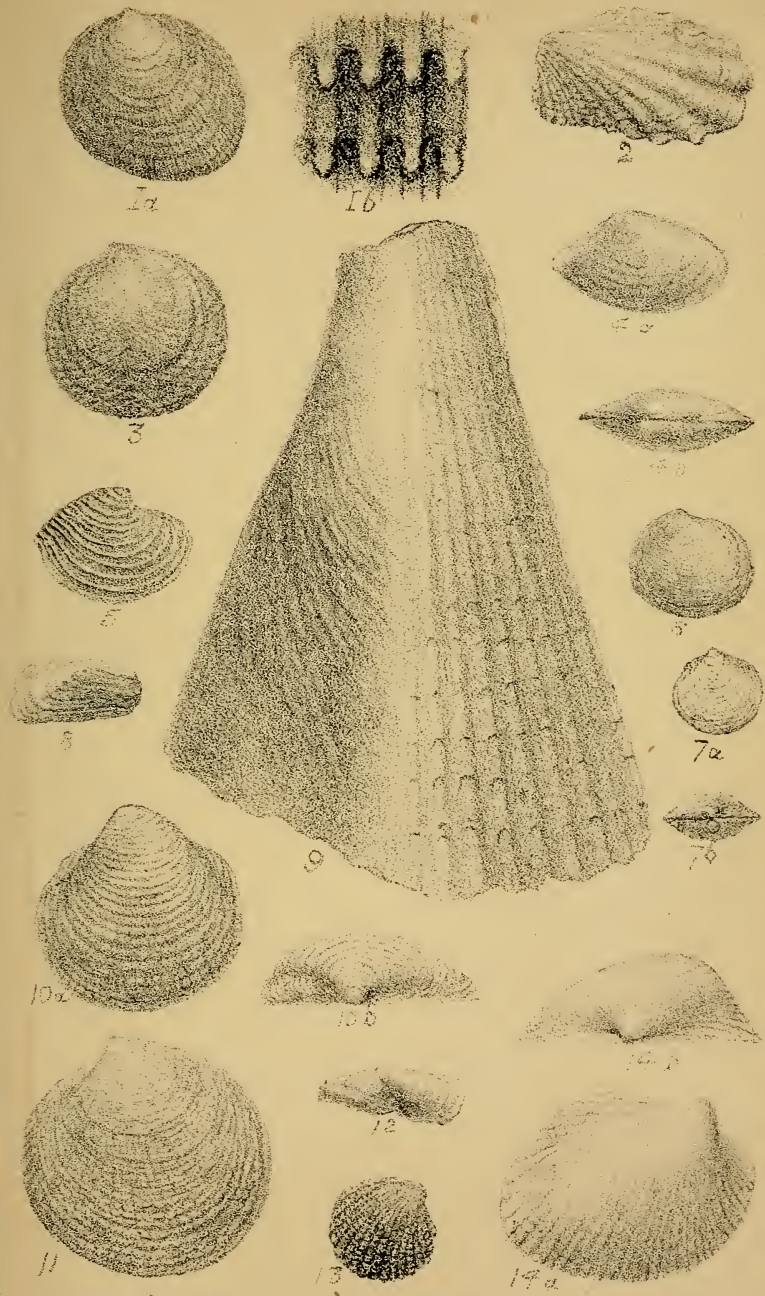
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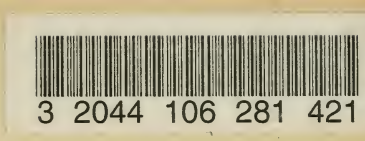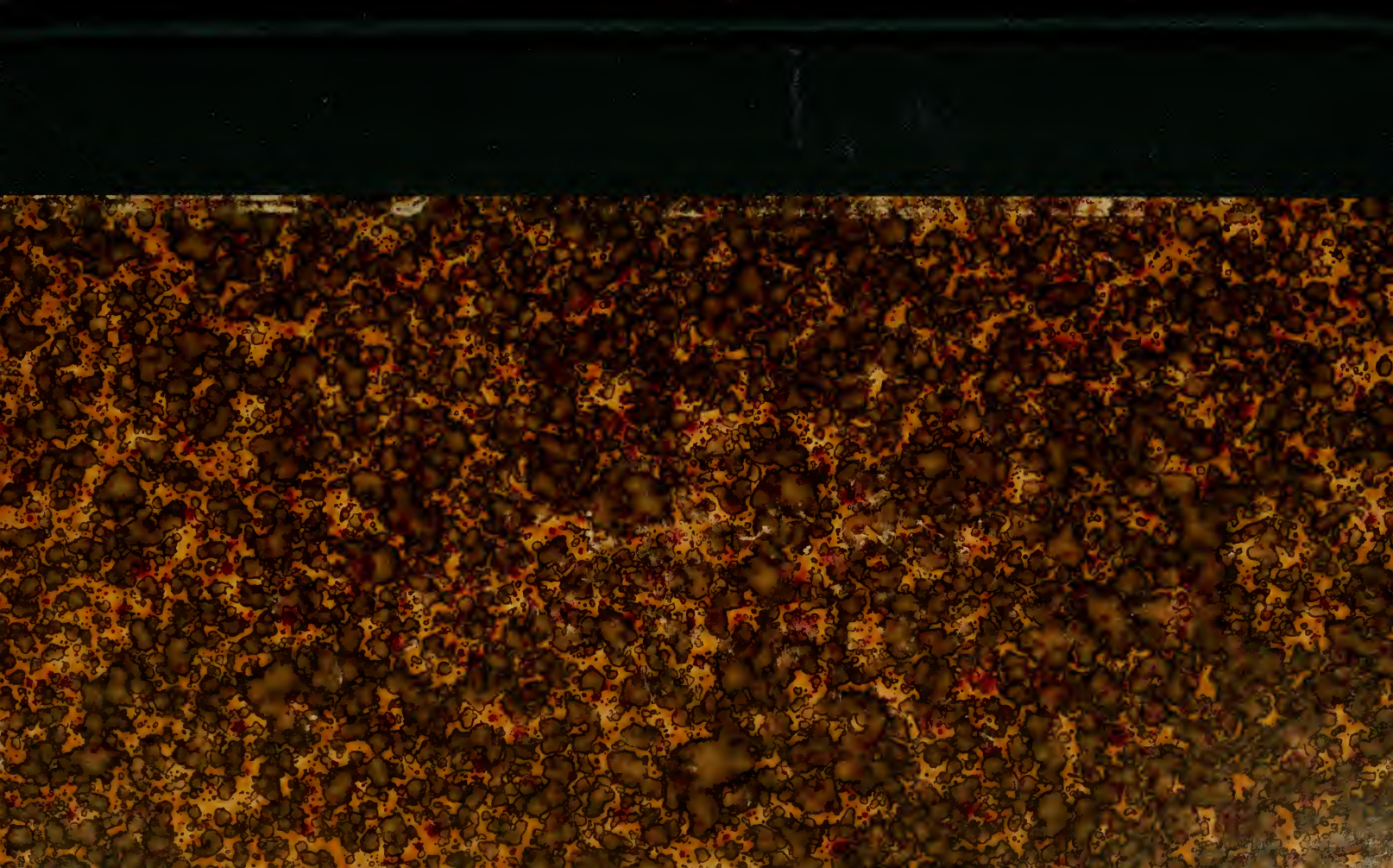
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